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Saggi/Essays

Rethinking health and disease in the era of personalized medicine

Alessandro Rosa^{*}

Abstract: Genome-based medicine, usually referred to personalized medicine, aims to provide tailored treatments for a single patient according to his/her genome. Thanks to correlations between genotype and phenotype, it is also able to assess the chances of developing a disease given to the presence of a specific genetic mutation. Within the aforementioned paradigm, the first challenge to address is to properly define what is usually meant by the expression ‘personalized medicine’, specifying the methodologies it uses and the premises it is based on. Then it appears fundamental to discuss whether and how such vision entails any change for our theoretical concepts of health and disease. I will argue that this is the case and, in particular, that being able to predict the probability of diseases’ occurrence can significantly affect our philosophical concepts of disease, illness and sickness in different ways.

Keywords: Personalized Medicine; Health; Disease; Genomic

1. Introduction

As the name suggests, personalized medicine is a medical paradigm that aims to get to the personal level, essentially by assessing diagnoses and providing therapies tailored for a single individual¹. To achieve such ambitious goal, personalized medicine relies on a growing corpus of knowledge regarding genotype-phenotype associations². At the most basic level possible, genes are what makes us as human beings: they encode for proteins that build our organisms, thus they are responsible for many bio-

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¹ Cf. for instance M. Hamburg, F.S. Collins, *The Path to Personalized Medicine*, “New England Journal of Medicine”, CCCLXXXIV, 4, 2010, pp. 301-304.

² Cf. A. Gamma, *Personalized and precision medicine*, in M. Solomon *et al.* (eds.), *The Routledge Companion to Philosophy of Medicine*, Routledge, New York 2016, pp. 411-421.

logical mechanisms involved in human physiology. Most of the human genome is identical across different individuals, but about 1% of it diverges in each person. This 1% is responsible for many of the variations that we are familiar with: some of us have green eyes, some blue ones, some are taller than others, there are people with red hair and people with black hair. These little variations are usually called single-nucleotide polymorphisms (SNPs) and they are also the probabilistic causes of many diseases related to genetic dysfunctions.

Personalized medicine embeds a vision according to which it is possible to take into account the consequences of all these SNPs to assess a specific diagnosis according to the genetic variation that a single individual carries. The underlying assumption is that we do not differ only in our external features, but also (and arguably, more importantly) in the features that predispose us to different disorders. The ultimate goal of personalized medicine is to consider these differences to develop more effective and safer drugs, assess more accurate diagnoses and elaborate better prognoses and provide predictions regarding future state of health.

Thanks to the newest technological advances in the biomedical field³, the dream of tailored treatments promises to become true. However, personalized medicine poses many challenges to several theoretical concepts related to medicine, and it is going to have practical impact as well. The focus on genes is likely to change many aspects of current clinical practice, and to raise many issues that might lead for some reshaping of future healthcare. As I am going to argue, personalized medicine is going to increasingly force us to rethink our concepts of health and disease: a large literature of philosophy of medicine questioned for many decades now what health and disease are, and the time has come to address such question under the light of the personalized medicine paradigm⁴. Moreover, as it is often the case when we discuss philosophical concepts in medicine, many ethical questions arise, in particular regarding the justification of those preventive treatments and the way in which healthcare is going to provide access to such treatments to all the patients.

In the first section I will provide a brief sketch of what personalized medicine is. Currently in medical literature the proper definition of person-

³ Cf. Akram Alyass *et al.*, *From Big Data Analysis to Personalized Medicine for All: Challenges and Opportunities*, "BMC medical genomics", VIII, 2015, pp. 33.

⁴ There are many volumes that try to address the issue with a philosophical perspective. Among these, cf. for instance, M. Gadebusch Bondio *et al.* (eds.), *Medical Ethics, Prediction, and Prognosis: Interdisciplinary Perspectives*, Routledge, New York 2017; T. Fischer *et al.* (eds.), *Individualized Medicine: Ethical, Economical and Historical Perspectives*, Springer, Cham 2015.

alized medicine is not entirely clear, and many terms have actually been proposed (e.g. precision medicine, stratified medicine, individualized medicine). To develop a proper framework for our philosophical investigation, I will start by considering the definitions given by the scientific literature and disentangle their ambiguities, claiming that they embody different sides of a more general biomedical paradigm. Then I will discuss the concepts of health and disease under the light of personalized medicine. I will focus my investigation on the well-known distinction between three different aspects of malady⁵ namely the distinction between disease, illness and sickness. I will briefly present those concepts and analyse how they are affected by the personalized paradigm, claiming that if we consider individuals already ill before a malady is taking place, personalized medicine is going to make a sharp distinction between symptomatology and the actual pathological condition. I will argue that, by detaching the symptoms from the malady, a sort of ‘de-temporalization’ of health is taking place. I will suggest that further philosophical reflections should be pursued which should get deeper into the consequences that such biomedical paradigm is going to have on the understanding and use of the concepts of health and disease.

In the following discussion I will mainly refer to oncology as the primary field in which personalized medicine has been successfully applied, due to the fact that cancer is a disease with a strong genetic component. However, an individualized approach can also be applied to the case of rare diseases. Often referred to as “orphan diseases”, rare disorders are usually related to genetic variations and mainly single-gene mutations⁶. Thus, personalized medicine has the potential to mark significant progresses towards the development of specific drugs for treating rare diseases which currently have no proper pharmaceutical treatment.

2. *Medicine at the personal level*

Following some fundamental discoveries in biomedical field – such as, e.g., penicillin to defeat bacterial infections – medicine has often thought

⁵ This distinction was originally laid out by Andrew Twaddle, but more recently it has been developed by Bjørn Hofmann. Cf. B. Hofmann, *Complexity of The Concept of Disease as Shown Through Rival Theoretical Frameworks*, “Theoretical Medicine”, XXII, 2001, pp. 211-236; Id., *On the Triad Disease, Illness and Sickness*, “Journal of Medicine and Philosophy”, XXVII, 6, 2002, pp. 651-673.

⁶ Cf. R. Trevor et al., *Rare disease terminology and definitions—a systematic global review: report of the ISPOR rare disease special interest group*, “Value in Health”, XVIII, 6, 2015, pp. 906-914.

about treatments according to the paradigm of ‘one drug fits all’. Accordingly, research has largely strived to develop ‘magic bullets’, i.e. drugs fighting directly pathogenic agents, and mean to invariably destroy them. Only with the works of Archibald Edward Garrod⁷, mostly forgotten until the mid of XX century, it started to appear that such model was not applicable to all cases. Garrod himself claimed that the way in which drugs are metabolized, and thus their efficacy, varies from individual to individual. From this simple but fundamental intuition the field of pharmacogenomics originated, a new branch of pharmaceutical and biomedical sciences focusing on how the effects of drugs are influenced by the genetic profile of the single patient. Reactions to the drugs have to do with “how the organism handles the drug (absorption, distribution and elimination), or changes in the direct response of the organism to the drug”⁸.

Personalized medicine aims to take into serious account individual differences to assess the best possible therapy for the single patient under investigation. Here the basic proposal is that, instead of developing magic bullets to cure all the occurrences of a disease in the same way, it would be best to develop targeted bullets, i.e. drugs that interact only in specific occasions. One of the fields that most benefited from this methodology is oncology. Until the late 70s, chemotherapy was the only strategy for fighting cancer, but it was indeed a costly one: chemotherapeutic drugs are highly cytotoxic, meaning that they negatively affect cells in the whole organism, without distinguishing between healthy and tumoral ones. Targeted drugs, instead of a scorched-earth strategy, try to aim only for the cells that went out of control. One paradigmatic example is a drug called tamoxifen which, by inhibiting the estrogenic binding in ER-positive cells, is able to stop cells replication in tumoral cells only, leaving the healthy ones almost intact, thus avoiding many of the major side effects of regular chemotherapy⁹.

During the last decades, one of the major scopes of biomedical research has turned into seeking relationships between gene variation and pathological conditions in order to gain insights of the underlying mechanisms involved in the latter. Thanks to the newest genome sequencing

⁷ Cf. A. Garrod, *The Incidence of Alkaptonuria: A Study in Chemical Individuality*, “The Lancet”, CLX, 4137, 1902, pp. 1616-1620.

⁸ H.E.M. Zu Schwabedissen, *The Role of Pharmacogenomics in Individualized Medicine*, in T. Fischer *et al.* (eds.), *Individualized Medicine: Ethical, Economical and Historical Perspectives*, cit., p. 94.

⁹ Cf. V. Craig Jordan, *Tamoxifen: A Most Unlikely Pioneering Medicine*, “Nature reviews Drug discovery”, II, 3, 2003, pp. 205-213.

technology, reading the human genome has constantly become easier and cheaper. Following the conclusion of the Human Genome Project, which was completed in 2003, the cost for a single complete genome screening has plummeted and machine learning algorithms used in bioinformatics allow researchers to intertwine large amount of -omics data (genomics, epigenomics, lipidomics, transcriptomics). This was the main step that allowed scientists and researchers to search for a way to develop personalized treatments.

By posing such attention to genotype-phenotypes correlations, both biomedical research and clinical practice are going to undergo significant changes. On the one hand, drug design is rapidly evolving: by knowing the molecular targets involved in a pathological condition, it is now possible to develop drugs aimed at only one specific target. This means that drug discover may become more analytical, thus less useful or even harmful compounds might be completely avoided¹⁰. In turn, this will also affect the way in which clinical trials are designed and evaluated. If we know that every individual has his/her specific genetic features, it only sounds reasonable to subdivide them according to their genome. Indeed, stratification is one of the core features of personalized medicine: once we know the genetic features that can influence the course of the disease, it is possible to create different clusters of patients that react in different ways to the same treatment.

In the actual clinical practice, stratification is going to play a fundamental role. To begin with, physicians can take advantage of the information they have regarding the genetic pool of their patients to make more thoughtful decisions regarding which drug to prescribe and in which dose. Having the complete genomic information of their patients, physicians would be able to prescribe and administrate more effective and safer drugs, according to case-by-case necessities. One recent example is Abacavir, which is commonly employed for AIDS patients¹¹ and which shows different effects according to a specific genetic mutation.

Analysing the pathological mechanism at the genomic level also significantly enhances our chances of dealing with rare disorders¹². Rare disorders are strongly related to genetic variations, and most of them are relat-

¹⁰ Cf. G.S. Ginsburg, J.J. McCarthy, *Personalized Medicine: Revolutionizing Drug Discovery and Patient Care*, "TRENDS in Biotechnology", XIX, 12, 2001, pp. 491-496.

¹¹ Cf. R.R. Shah, D.R. Shah, *Personalized Medicine: Is It a Pharmacogenetic Mirage?*, "British journal of clinical pharmacology", LXXIV, 4, 2012, pp. 698-721.

¹² Cf. Francesc Palau, *Personalized medicine in rare diseases*, "Personalized medicine", XIX, 2, 2012, pp. 137-141.

ed to single-gene variations, making them heritable diseases which significantly affect all family members that share the same genome. Therapeutic options for rare diseases are usually scarce and this entails that there are millions of people nowadays lacking proper medical treatment (despite their rarity, there is a huge variety of rare disorders, and thus as whole they affect a high number of individuals). A personalized approach in drug development, for instance, could lead to major advances in the development of proper biomarker for rare diseases, consequently improving our understanding of the pathological mechanisms underlying the malady, and thus increasing the chances of developing appropriate pharmaceutical therapies.

The most important theoretical change (at least with respect to the reflections pursued here) is the fact that with such knowledge regarding genotype-phenotype associations it became theoretically possible to make assessments regarding individuals' future states of health. Since we get our genes before we are born, personalized medicine is not only able to cure according to genetic features, but also to evaluate the probability of the occurrence of future pathological conditions. Oncology, again, offers a paradigmatic example: BRCA-1/2, a gene whose mutations are correlated to a high incidence of breast cancer in women¹³. In this sense, it is usually said that BRCA-1/2 is a biomarker for breast cancer, meaning that its mutation indicates a serious predisposition for the disease. The main problem that I will try to address in the following pages is whether such predisposition can then be understood as the philosophical concept of disease, and in what relations the two stands. Before that, however, I am going to explore more in depth the definition of personalized medicine itself.

3. *Personalized medicine: Many names for the same thing?*

Most of the debate around personalized medicine has been focusing on the question 'hype or hope?', thus asking whether a complete personalization of treatments could become reality or it is only intended as an idealistic goal¹⁴. Less effort was spent to propose a clear definition of the

¹³ Cf. S.A. Narod, W.D. Foulkes, *Foulkes Brca1 And Brca2: 1994 And Beyond*, "Nature Reviews Cancer", IV, 9, 2004, pp. 665-676.

¹⁴ Cf. for instance F.S. Collins, H.A. Varmus, *New Initiative on Precision Medicine*, "New England Journal of Medicine", CCCLXXII, 9, 2015, pp. 793-795.

expression “personalized medicine”, for instance to understand whether it can be encompassed in a single definition or if it has to be conceived as an umbrella-term that includes heterogeneous aspects¹⁵. As a consequence, scholars and researchers tend to use different expressions when they refer to a personalized approach depending on the specific situation, leading to what I believe is semantical misunderstanding. Here I will analyse the different ways in which personalized medicine has been addressed by scholars and researchers (that are: precision medicine, stratified medicine and individualized medicine) and try to identify patterns of usage, in order to make some (hopefully) clear distinctions. My suggestion here is to identify the different expressions that have been adopted in the scientific literature as sorts of sub-parts of a more comprehensive sense of ‘personalized medicine’, which should be intended as a paradigm¹⁶ (in the Kuhnian sense of the term), or, as it has been argued, as “sociotechnical imaginary”¹⁷. I believe that by doing so we could have a better understanding of what kind of practice personalized medicine is, what are the methods on which it relies on and what are its theoretical implications, which are going to be explored in the next and final section.

First of all, much focus has been put on the different strategies to stratify population according to their genetic features. For this reason, ‘*stratified medicine*’ is a rather popular choice among expressions in medical literature¹⁸, as it clearly indicates the methodology that has been used. This approach aims to stratify the groups of patients at the finest possible level, i.e. to have small clusters of patients representing every single mutation that is relevant for a pathological condition. Ideally, these small groups could be so sophisticated to include only one single individual, but this is not strictly required. Instead of treating a group of patients (for instance, all of those who suffer from cardiovascular disease) with the same drug, it is possible to subdivide them according to different criteria (usually genetic ones) and administrate different drugs to

¹⁵ Cf. D.M. Roden, R.F. Tyndale, *Genomic Medicine, Precision Medicine, Personalized Medicine: What’s In A Name?*, “Clinical Pharmacology & Therapeutics”, XCIV, 2, 2013, pp. 169-172.

¹⁶ The debate whether personalized medicine is actually a complete new biomedical paradigm is still open. Cf. for instance M. Gadebusch Bondio, F. Spöring, *Personalized Medicine: Historical Roots of a Medical Model*, in G. Boniolo, M.J. Nathan (eds.), *Philosophy of Molecular Medicine*, Routledge, New York 2016, pp. 43-64.

¹⁷ H. Tarkkala et al., *From Health to Wealth: The Future of Personalized Medicine in the Making*, “Futures”, CIX, 2019, pp. 142-152.

¹⁸ Cf. A. Greystoke, A. Chaturvedi, *An Introduction to Stratified Medicine*, “Drug Discovery Today”, XX, 12, 2015, p. 1409.

each of them. From a methodological point of view, stratified medicine is the first step to reach an actual personalized medicine, as it allows both biomedical researchers and healthcare professionals to make more rational classifications of diseases according to their risk factors, thus providing a better understanding of biological mechanisms.

Secondly, the term '*precision medicine*' is often used as a synonym for personalized medicine. When biomedical researchers talk about precision, they mostly refer to the ability of looking at the molecular level to understand every single point of a biological mechanism¹⁹. The main advantage of this approach is that by targeting only the molecular points involved in the physiological dysfunction there is less risk of harming the organism of the patient and, at the same time, higher chances of actually fixing the broken biological pathway. Nevertheless, one should not forget that more precise does not automatically mean better. If taken by itself, precision medicine only requires operating at the molecular level to target only the essential points of the mechanisms involved in the disease and leave the rest untouched. But the incredible complexity of biological organisms cannot always be tackled according to such an approach: the development of pathological conditions cannot be reduced only to a form of genetic determinism, as there are many factors that can concur²⁰.

Thirdly, the differences between '*individualized medicine*' and 'personalized medicine' are often very slight. The semantic shift might also be due to different language origins; for instance, Tobias Fischer et al.²¹ argues that for German speakers 'individualized medicine' is often preferred to 'personalized medicine', which is more commonly used in Anglo Saxon areas. If stratification and precision are indispensable tools for a medicine able to develop tailored therapies, individualized medicine stresses out the importance of taking into account specific individual needs. Personalized medicine does not only aim to be a precise and targeted medicine, but most likely a form of medicine that takes into consideration *all* the relevant evidence. To achieve such goal it is fundamental to include "genetic background, age, gender, environmental risk factors, lifestyle, culture and beliefs as well as social status in the overall predisposi-

¹⁹ Cf. J.L. Jameson, D.L. Longo, *Precision Medicine: Personalized, Problematic, and Promising*, "Obstetrical & Gynecological Survey", LXX, 10, 2015, pp. 612-614.

²⁰ Cf. A. Gamma, *The Role of Genetic Information in Personalized Medicine*, "Perspectives in biology and medicine", LVI, 4, 2013, pp. 485-512.

²¹ Cf. T. Fischer et al. (eds.), *Individualized Medicine: Ethical, Economical and Historical Perspectives*, cit.

tion of individuals to specific diseases, the disease development, the natural course of disease and the response to therapeutic intervention”²².

In the end, I believe that most of the enthusiast scholars prefer to use ‘*personalized medicine*’ due to the fact that, from a semantic point of view, ‘personalized’ automatically implies the acknowledgement of a sort of primary importance of the patient as a person. If that is the case, it should be noted that the expression ‘personalized medicine’ could, however, be misleading: although a more person-centred medicine is indeed hopefully to be included in every aspect of clinical practice, the methodology that has been actually pursued in biomedical research under the label of ‘personalized medicine’ has little to do with that. Taken by itself, personalized medicine is simply the sum of stratification strategies and precision at the molecular level. This, of course, does not automatically imply that a person-centred approach is not compatible with the methods and goals of personalized medicine, but the discussion of this point goes well beyond our argumentation.

So, where do the differences actually lie? The different terms used to talk about personalized medicine are not merely different names for the same thing, but they indicate different aspects of this whole new approach in health care. I suggest personalized medicine should be conceived as a combination of:

- a) a stratification approach that plans to subdivide groups of patients affected by the same type of disease on the basis of
- b) a deep knowledge of the molecular features and potential differences among specific cases of the same disease to
- c) correctly assess the risks of undergoing a certain treatment and/or taking a certain drug
- d) in order to develop and administrate the most appropriate pharmacological therapy for each single patient.

To achieve all of these goals, personalized medicine relies on new information technologies and digital tools that gather huge amount of data regarding the single patient and integrate them with the data already gathered from other patients that share some characteristics with him/her.

Currently, those goals are far from being reached, and some scholars are starting to use the term “semi-personalized medicine”²³ to describe a

²² O. Golubnitschaja *et al.*, *Medicine in the Early Twenty-First Century: Paradigm and Anticipation-EPMA Position Paper 2016*, “EPMA Journal”, VII, 1, 2016, p. 2.

²³ Cf. N. Marino *et al.*, *Breast Cancer Metastasis: Issues for the Personalization of Its Prevention and Treatment*, “The American Journal of Pathology”, CLXXXIII, 4, 2013, pp. 1084-1095.

clinical practice in which stratification and molecular precision play a fundamental role. However, despite still in development, the premises of personalized medicine are already affecting our concepts of health and disease. Does personalized medicine provide a new biomedical paradigm to conceive health and disease? As Thomas Kuhn famously remarked,²⁴ one important feature of paradigm shifts is that they provide scientists with tools with which they can see reality in a new and different way. Admittedly, since the conclusion of the Human Genome Project, biomedical research has fundamentally changed its trajectory by giving ever more weight to genomic data. Therefore, we should now turn our attention to ways in which personalized medicine affects our theoretical concepts regarding medicine: to what extent are they affected, and how?

4. *Health, disease, illness and sickness*

As it was previously mentioned, Bjørn Hofmann has elaborated a useful framework to understand the debate around health and disease. Stressing that we should start off from the concept of disease he claims that a pathological condition can be a disease, an illness or a sickness depending on the level that we are interested in. It may be the case that, in a given situation it is all the three at the same time; this would make it the 'ideal' case and the less controversial one. There are, though also cases in which it is more difficult to assess in which sense an individual has a pathological condition (for instance in case of illness without disease).

The term 'disease' refers to the way in which scientists and healthcare professionals assess that a certain condition is pathological, which is usually made by performing measurements of specific biological parameters. It is strictly related to the way in biomedical knowledge that scientists have, for instance the fact that a high cholesterol level is associated with cardiovascular malfunctioning. This is intended to be as objective as possible: no personal or normative evaluations are included in such measurements, what is crucial is the data that are gathered.

The term 'illness', on the other hand, is related to how individuals feel: do they feel pain? What are their symptoms? Are they suffering from mental discomfort due to their condition? Do they consider themselves as patients in need for a treatment or not? The point is that there are some

²⁴ Cf. T. Kuhn, *The Structure of Scientific Revolutions* (1962), *La struttura delle rivoluzioni scientifiche*, tr. it. by Adriano Carugo, Einaudi, Torino 2009.

variables that cannot be just measured objectively by medical staff and that are related to the personal experience, i.e. how one lives her/his condition pathological condition. The domain of illness includes all the sensations (usually negative ones) that we feel as individuals, but there is a sense in which every one of us is part of a larger collective, hence there is a social sense of disease. We thus have ‘sickness’, i.e. the malady as it is perceived by ‘others’, by society in the broadest sense possible. This includes not only how sick individuals are seen by the people that surround them (relatives, friends, co-workers etc.), but in a broader sense by societal institutions (government, public health care, companies etc.). The concept of sickness is fundamental, as usually people are treated as patients only when social institutions recognise them as patients.

With the triad framework it is easy to understand the main disagreements between different accounts of health and disease. The most established account of naturalism in medicine is Christopher’s Boorse²⁵ biostatistical theory (BST from now on). According to Boorse, “health is the normal functioning, where the normality is statistical and the functions biological”²⁶, meaning that to define health we have to look at the way in which organisms function in their “natural” way. For instance, to be healthy one must have a normal heart, which is just a heart that fulfils its main purpose, which is pumping blood into circulation.

Describing ‘normal’ is far from being an easy task, but according to BST we can limit ourselves with the statistical meaning, i.e. considering normal what, from a biological point of view, appears to be the common with respect to a certain reference class (e.g. Caucasian men of age above 65). As for functions, they are intended as a form of contribution for a goal: the heart normally pumps blood because it contributes to the general goal of making the organism survive. Therefore, a particular condition is pathological only when there is a sort of malfunctioning in the physiology of the individual, as compared to the way in which it normally works. For instance, a certain level of cholesterol in the blood stream of an individual is currently referred to as hypercholesterolemia and it is treated as a disease (for example, with drugs able to lower the level of cholesterol).

It is clear that according to Boorse a pathological condition is equal to a disease, in the sense illustrated above. Does this mean that we should

²⁵ Cf. C. Boorse, *On the Distinction between Disease and Illness*, “Philosophy & public affairs”, V, 1, 1975, pp. 49-68; Id., *Health as a Theoretical Concept*, “Philosophy of Science”, XLIV, 4, 1977, pp. 542-573 and Id., *A Second Rebuttal on Health*, “Journal of Medicine and Philosophy”, XXXIX, 2014, pp. 683-724.

²⁶ C. Boorse, *Health as a Theoretical Concept*, cit., p. 542.

not care about the personal experience of the patient? This is not the case. In fact, Boorse specifically addressed the problem by claiming that personal experience of pathologies (e.g. the symptoms that the patient suffers) are not entirely denied by BST, but they are conceptually subordinate with respect to biological malfunctioning. Illnesses exist, but they “are merely a subclass of disease. Namely those disease that have certain normative features reflected in the institution of medical practice”²⁷. According to Boorse, there might be cases in which illness is present along with disease, whereas the opposite is not possible.

Anti-naturalism approaches oppose this overall framework by claiming that there is nothing ‘natural’ in the concepts of health and disease. One approach that denies naturalism is normativism. The key feature of normativism is that health cannot be entirely reduced to a natural concept, as the way in which we use health and disease terms are strictly dependent on the norms that we adopt. In other words, health is a state that has a positive value for us as a single individuals or as a social group, while disease is something that we regard as harmful for us. According to Rachel Cooper, “by disease we mean a condition that it is a bad thing to have, that is such that we consider the afflicted person to have been unlucky, and that can potentially be medically treated”²⁸. This, of course, does not mean that biology has nothing to do with health. What is stressed out by normativists is that we should firstly consider the meaning that health and disease have for us, i.e. our personal experience as patients and social conceptions. This entails, among others, that such concepts are subject to change due to shifts in the cultural context.

One famous example that might shed light on the issues involved in the naturalism/normativism debate is provided by the case of homosexuality, which was considered a disease by the first edition of the *Diagnostic and Statistical Manual of Mental Disorders* and was only removed in 1973 after a heated debate²⁹. Homosexuality was considered a disease for a lot of reasons that nowadays we would reckon as mere prejudices regarding homosexuals, and we will all currently neglect that it is a disease.

Differently from what naturalism holds, according to normativism illness and sickness are conceptually prior to disease, i.e. it is more important to consider how patients feel and how society consider them than to

²⁷ C. Boorse, *On the Distinction between Disease and Illness*, cit., p. 56.

²⁸ R. Cooper, *Disease*, “Studies in History and Philosophy of Biological and Biomedical Sciences”, XXXIII, 2002, p. 271.

²⁹ Cf. R.L. Spitzer, *The Diagnostic Status of Homosexuality in DSM-III: A Reformulation of the Issues*, “American Journal of Psychiatry”, CXXXVIII, 2, 1981, pp. 210-215.

count, e.g., how many blood cells he/she has in circulation. There are obviously many ways of identifying good and bad values and this is not the place to address them thoroughly, but basically a pathological condition is something that causes some kind of harm to the person, while health is something desirable. The focus is on the harm that the individual suffers and less on the biological dysfunction that is going on in his/her organism.

To conclude, according to naturalism a pathological condition is always a disease, which only in some cases can also be intended as an illness. For normativism, on the other hand, illness and sickness are primary concepts for understanding a pathology, as personal evaluations and social norms actually shape the way in which we intend pathological conditions³⁰. Given this traditional framework, let us now ask: in which ways does personalized medicine affect this debate? Does the focus on genomic data bring any consequences on the concepts of disease, illness and sickness? Does a predisposition for a disease count the same as a pathological condition? The next section will provide some tentative answers to these questions.

5. *Health and disease in the era of personalized medicine*

As recalled above, personalized medicine does not only want to achieve custom-made treatments, but also tailored predictions. According to this approach, people might receive relevant information on the basis of genetic tests before any sign of the disease has even occurred. For instance, it might be assessed that a particular woman has an 85% chance of developing breast cancer in her life due to the fact that she is a BRCA-1/2 carrier. To have predictive tools is indeed a great opportunity for medicine, and it comes without doubts that it might significantly enhance clinical practice; however it also has serious implications for our concepts of health and disease – as well as, it goes without saying, for the perception of one own's condition and for related personal decisions.

To begin with, one could argue that if personalized medicine heavily relies on genetic traits to predict the occurrence of a malady, it implies that pathological conditions are thereby conceived as biological dysfunc-

³⁰ The description of the debate depicted above is, of course, highly simplified. The contrast between naturalism and normativism can be analysed at many different levels and from many different points of view. For an overview, also cf. Elseltjn Kingma, *Naturalism about health and disease: adding nuance for progress*, "The Journal of Medicine and Philosophy", XXXIX, 6, 2014, pp. 590-608.

tions, in the sense that we have illustrated in the previous section. Let us wonder: is being predisposed for a particular condition the same as having a biological dysfunction? Is it a matter of fixing threshold, i.e. is there a certain value of risk above which it is possible to claim that a predisposition is already a disease? Is personalized medicine creating a new category of patients, people who are both healthy and ill at the same time just due to the fact that they carry a particular genetic mutation?

Genetic biomarkers, as it is the case of BRCA-1/2, are not intended to hint that a biological process is not working properly, but only that such event may occur in an unknown future, i.e. they indicate a predisposition for a pathological condition. Where does this sort of predisposition lie within the naturalists' approach? According to Boorse, this cannot just count as a disease. In order to be a disease, a condition has to be a "an impairment of normal functional ability"³¹, i.e. a biological *dysfunction*. Genetic mutations associated with risk do not always trigger and then lead to a disease, as they are not always a dysfunction *per se*. In this sense, a sort of 'detachment' of disease from its symptoms is in place. However, the issue here is not only the fact that there might be cases in which there is disease without symptoms (which is rather a common scenario in infective diseases, for instance), but whether it makes sense to claim that there can be situations in which there is not any biological dysfunction and still someone is considered as a patient and treated accordingly.

If we look at the molecular level, almost everyone has some kind of genetic glitch: SNPs are rather common and, in fact, they make us unique human beings. If we consider genetic mutations as biological dysfunctions, are we claiming that everyone is diseased? Accepting such conclusion would be undoubtedly too costly for naturalists, as it would imply that there is no one who is disease-free: were we to go that far, at the end of the day the very distinction between health and disease would turn out to be vacuous. According to Boorse's BST variation does not imply malfunctioning, so even if everyone has some genetic glitch this does not mean that he/she is diseased. Boorse might have not been thinking about genes in particular, but he includes both variation and dysfunction in his BST exactly to counter this kind of objection; for instance, since it does not entail any impairment, it is not true that people who have red hair are diseased even if such trait is not common among the human population.

³¹ C. Boorse, *Health as a Theoretical Concept*, cit., p. 8.

However, there is a sense in which biomarkers can be intended as dysfunctions in the context of personalized medicine. Consider the case of BRCA-1: as BRCA-1 is involved in DNA repairing, a variation in such gene could cause failures in DNA replication, which in turn could lead to breast cancer. In this case, the presence of the mutation tells us that a dysfunction is already going on, although it did not already lead to the exterior symptoms. Thus we could claim that the individual is diseased, although he/she does not suffer from the disease that the mutation is associated with (in this case, breast cancer). If that is the case, we should make a distinction between two possible scenarios: one in which there is an altered version of a gene, which can cause the breakdown of a biological mechanism and is already on going, and a second case in which the mutation is present, but it has not (yet) been involved in any pathogenic processes. It is clear that the second case cannot be addressed as a case of biological dysfunction, as there is not any mechanism that is not working as it is supposed to do. As for the first case, I believe that we should actually be talking of biological dysfunction, thus claiming that a form of disease is present, even though the pathology we are screening for is not there.

Of course, risk factors are not entirely born with the development of personalized medicine, nor with the current study of genomics. Health states like obesity can account as potential risk factors for cardiovascular diseases without being themselves diseases; also traditional cancer screening does not rely on genetic tests (consider for instance the first wave of mammographies that started in the 70s), and it can detect small tumoral masses that have not yet started to spread through the organism, which would lead to a proper biological dysfunction³². However, I believe that the case of personalized medicine is different, not only regarding its magnitude, but also conceptually.

In the aforementioned cases, it seems to me that the issue is a matter of threshold: small tumours are not (yet) diseases because they are *small* at a given time, but in the moment in which they expand they are probably going to be regarded as proper diseases. Obesity is not a malady per se, but it could lead in the future to cardiovascular diseases; however, those cardiovascular diseases are going to be caused by some biological dysfunctions that are already taking place in the patient. In contrast, personalized medicine claims that we could potentially talk of a state of dis-

³² P.H., Schwartz, *Small Tumors as Risk Factors not Disease*, "Philosophy of Science", LXXXI, 5, 2014, pp. 986-998.

ease even in case there is biological abnormality or dysfunction of any sort except for genetic mutations that have not already started to modify any biological mechanism in the organism³³.

As for the individual level, namely what concerns illness, the fundamental issue could be summarized in one simple, yet complicated to discuss, question: are people who carry malignant mutations already patients? In other words, is predisposition sufficient to label someone as ill and to treat her/him as such? Some distinctions need to be in place. According to normativist accounts, which are primarily interested in the concept of illness, in order to be considered as pathological, a condition needs to somehow be a burden for the individual (it has to be a 'bad thing to have', to use Cooper's words). This is often intended as 'it needs to cause symptoms on the individual e.g. to cause pain or lead to some sort of impairment.

As at the time of the screening, in the absence of symptoms, the individual is more likely to think of him or herself as healthy, considering him/her a patient at that point would go against his/her personal evaluation. Personalized medicine wants to gather more objective evidence regarding the status of the patient through the reading of -omics data, but normativism would reject such a view, arguing that there cannot be objective, value-free criteria for labelling a condition as pathological. If one does not suffer from any symptoms there is no illness. In this sense, the quest of personalized medicine to gain an objective knowledge of the health status of individuals would go against the individuals' norms and might thus be seen as a form of forced medicalization.

Nevertheless, if we consider the way in which such predictions can change the lives of those who undertake genetic tests, things may appear differently. For instance, consider the case of a woman who decides to undergo a genetic test for BRCA-1/2 mutations and that gets a positive result. These people live in a strange limbo: they are not diseased, as they have not got cancer, and yet they are not considered as healthy as the average population, and they have to be constantly monitored by the healthcare system. They also have to face some difficult ethical dilemmas³⁴ in order to decide whether they should take preventive measures

³³ However, I still agree with Schwartz conclusions: in the actual clinical practice, it does not matter that we could or could not claim that a condition is a disease to justify medical interventions, but we should more likely consider whether such interventions reduce the chances of morbidity and mortality.

³⁴ Cf. G. Boniolo, V. Sanchini (eds.), *Ethical Counselling and Medical Decision-Making in the Era of Personalised Medicine: A Practice-Oriented Guide*, Springer, EPub 2016.

(even drastic ones) or not. Some scholars refer to them also as “healthy ill”³⁵ or “healthy sick”³⁶, with an emphasis on the fact that they are at the same time healthy and characterised by a predisposition for a pathological condition.

A diagnosis of high-risk condition might be considered as a proper illness, insofar as the prediction itself can cause significant harm to the individual, e.g. in the form of anxiety and mental stress. From the moment in which they are identified as carriers for a mutation accountable for a pathological condition (e.g. breast cancer), their “illness identity” starts to develop³⁷: they are not patients for the disease they are being tested for, but for the experience that they are living as carriers. For instance, carriers of BRCA-1/2 mutations are not cancer patients, and yet they live in a very similar way: they tend to absorb the medical vocabulary, gather tons of information regarding cancer, start connecting with other people who have found out to be carriers or who are cancer patients. They are completely immersed in the biomedical context of their disease, the attitude of their beloved ones is likely to change as well. Apparently, there are two different forms of health: the present one, which might be disease-free, and the future one, which can be predicted with some sort of degree and, despite not being realized, still can still affect the individual.

It is hard to conceptually understand what it means to be healthy and ill at the same time, mainly because we are used to think of health as something that belongs to our current time. We are, at a given moment in time, healthy or ill depending on how we are feeling. Personalized medicine, however, manages to detach our personal perception of malady from the actual mechanisms of disease, so that what are we feeling now is no longer indicative of our health-status. If we start to think according to this framework, we can distinguish two different kinds of health: the present one, which is related to how the individual feel and to the current biological functioning of his/her organism; and the future one, which is related to how the genetic traits are going to shape, in probabilistically terms, his/her organism.

³⁵ Cf. J.-Ch. Pöder, H. Assel, *The Concept of Disease in the Era of Prediction*, in T. Fischer *et al.* (eds.), *Individualized Medicine: Ethical, Economical and Historical Perspectives*, cit., pp. 165-180.

³⁶ Cf. M. Langanke *et al.*, *Patients' Responsibility for Their Health*, in T. Schramme, S. Edwards (eds.), *Handbook of Philosophy of Medicine*, Springer, Heidelberg 2017, pp. 620-640.

³⁷ Cf. G.A. Sulik, *Managing Biomedical Uncertainty: the Technoscientific Illness Identity*, “Sociology of Health & Illness”, XXXI, 7, 2009, pp. 1059-1076.

Finally, let us turn ourselves to the concept of sickness, i.e. the malady as it is seen by society. The issues regarding society and health are very extensive and it would be impossible to fully address them here. Let me then just focus on a particular problem that, I believe, gives us precious insights on the matter, namely the relationship between personal health and responsibility under the light of personalized medicine³⁸. The problem, which exists even outside the realm of personalized medicine and genomics, is usually summarised as follows: are people responsible for their own health? Can they be blamed for not being healthy? If so, are healthcare systems allowed to make a sort of hierarchy of patients (e.g. dividing them on the basis of how much they take care of their health) and provide treatments and services accordingly?

Since its beginning, personalized medicine has been addressed as a form of empowerment for patients. The fact that people could be able to gather information regarding their own genome, i.e. the building ‘bricks’ that constitute their organisms, has been seen as a way to take more careful and well-planned decisions about their lifestyle. Francis Collins, in one of his famous books regarding genomic medicine, constantly invites the readers to “join the personalized medicine’s revolution”³⁹ and even provides steps to improve one’s health according to genetic tests. The presence of Direct-To-Consumer genetic tests on the market is another element of ‘democratization’ of health, as companies that provide those tests offer them at affordable price⁴⁰. Furthermore, the rise of wearable devices designed to monitor health information such as blood pressure, cardiac rhythm, sleep patterns, etc., has also provided a wide range of tools for individuals to keep track of their health status without getting directly in touch with healthcare professionals⁴¹.

The question here is to see how healthcare systems and social institutions would react to such empowerment of the patients due to personalized medicine’s paradigm. A vast amount of information regarding their own health could make individuals more aware of their conditions, but al-

³⁸ Cf. for instance M. Langanke *et al.*, *Patients’ Responsibility for Their Health*, in T. Schramme and S. Edwards (eds.) *Handbook of Philosophy of Medicine*, cit., pp. 620-640.

³⁹ Cf. F.S. Collins, *The Language of Life: DNA and the Revolution in Personalised Medicine*, Harper-Collins, Epub Edition, 2010.

⁴⁰ Cf. P. Borry *et al.*, *Where Are You Going, Where Have You Been: A Recent History of the Direct-To-Consumer Genetic Testing Market*, “Journal of Community Genetics” I, 3, 2010, pp. 101-106; E.M. Bunnik *et al.*, *Personal Genome Testing: Test Characteristics to Clarify the Discourse on Ethical, Legal and Societal Issues*, “BMC medical ethics”, XII, 1, 2011, pp. 11-24.

⁴¹ Cf. M. Ruckenstein, N. Dow Schüll, *The Datafication of Health*, “Annual Review of Anthropology”, XLVI, 2017, pp. 261-278.

so more exposed. As biomedical research develops, more and more genetic variations might be associated with pathological conditions, meaning that more people would be labelled as sick despite their personal evaluation. If this is the case, the aforementioned alleged empowerment should be rediscussed. On this regard, one of the major issues that social institutions need to further address in the near future is the way in which the genomic data taken from donors and/or consumers are gathered, managed and distributed⁴².

The important thing here is to understand whether interventions are justified or not, and if so, in which scale and to what extent. We might decide to consider people responsible for their health, especially in an era in which gathering health information is easy and affordable; it is theoretically possible (but still very debatable) to blame individuals for careless behaviours, such as smoking or ignoring healthcare advice; still, what would such an assessment of responsibility led to? In any case, “we cannot decide not to have the genetic mutation in our bodies”⁴³: genome medicine stresses out the fact that many of our ‘faults’ are ‘by design’ and they are only related to the genome we are born with. For clinical practice this is indeed a relevant message, as it encourages researchers to develop target treatments; for society it should be recalled that people with malignant mutations should not be disadvantaged in any respect.

Furthermore, it might be highlighted that ‘our’ genome is not only ours, but it is shared among a wide range of individuals, namely our relatives. Thus, predisposition for pathological conditions do not only concerns single individuals, but also their relatives⁴⁴. In fact, I believe that this is also another significant difference between standard risk addressing and personalized medicine. It is not entirely new for medicine to consider previous cases of pathological conditions in members of the same family, but with the pivotal role of genes in personalized medicine it is more likely that this side will be taken into more serious account. Guidelines related to genetic screening usually suggest making contact with your family’s members before and after genetic tests. It may be the case

⁴² Cf. for instance S. Leonelli, *Locating Ethics in Data Science: Responsibility and Accountability in Global and Distributed Knowledge Production Systems*, “Philosophical Transactions of the Royal Society”, CCCLXXIV, 2083, 2016, pp. 1-12.

⁴³ R. Campaner, M. Cerri, *Manipulative Evidence and Medical Interventions: Some Qualifications*, “History and philosophy of the life sciences”, XLII, 2, 2020, p. 11.

⁴⁴ Cf. J.N. Weitzel *et al.*, *Genetics, Genomics, and Cancer Risk Assessment: State of the Art and Future Directions in the Era of Personalized Medicine*, “CA: a cancer journal for clinicians”, LXI, 5, 201, pp. 327-359.

that there is a family member who had developed a pathological condition which is known to be hereditary (as it is the case of BRCA-1/2). But it is also important to share the results of tests with relatives, as it can have important repercussion for their health. If that is the case, we might wonder whether healthcare system of the future will consider as sick not only individuals who carry predispositions for a disease, but also their families. This would change the way in which institutions consider sick people, and it may also further concerns over the actual rights and the privacy of those individuals.

As it is often the case when we inquire into medical matters, there are also many ethical issues that need to be addressed. When we talk about personalized therapies, similar to the case of rare diseases (which are, not by mere chance, often referred to as “orphan disease”) we face the problem of developing and administering drugs that are meant for a very small number of patients. It is true that by avoiding wrong pharmaceutical therapies some costs would be cut down, but it is also true that the costs for developing individualized therapies is going to skyrocket in the near future⁴⁵. Who is going to uphold such increased costs? Private pharmaceutical companies, public healthcare systems, or the patients themselves? If the problem is the allocation of resources, it makes only sense to ask whether every individual (or groups of individual) is going to benefit from personalized medicine or if it will provide more advantages for some particular cases. Oncology is probably the field that has gained more from this approach, but it is a very heterogeneous field, and it is not clear that every oncological patient is going to benefit in the same way. To decide who and in which extent is going to access such kind of therapies is going to be a complex task to address in the near future by healthcare policymakers.

6. Conclusions

At the moment, a universal definition of personalized medicine is not available yet and many scholars prefer to stress out some of its core features by using specific terms (e.g. precision medicine, stratified medicine, individualized medicine). Here I have suggested to use the expression ‘personalized medicine’ as an all-encompassing term that comprehends a

⁴⁵ Cf. Maks Takinikar, Petra Došenović Bonča, *Personalised Medicine in Public Healthcare Systems*, in N. Bodiroga-Vukobrat *et al.* (eds.), in *Personalized Medicine in Healthcare Systems: Legal, Medical and Economic Implications*, Springer, Cham 2019, pp. 269-281.

precision approach (i.e. it looks at the molecular level and at the role that genes play in pathological conditions), a stratification approach in which patients are subdivided according to molecular criteria (for instance, all the women that have a BRCA-1/2 mutation), and an individual approach, according to which clinical professionals should take into account all possible features of their patients, including but not limited to sex, age, life habits, genetic profile, diet, clinical history, etc. Moreover, it can be seen as an opportunity to tackle the issue of rare disorders, which are currently undertreated.

As we have seen, this new approach in medicine can potentially challenge most of our theoretical concepts regarding health and disease. By allowing physicians to draw predictions regarding future states of disease, health is somehow de-temporalized, insofar as that the disease is detached from its symptoms. Being able to calculate the chances of developing a disease based on a genetic test open many scenarios. For instance, people may be labelled as 'healthy-ill' i.e. individuals who are in a present state of health but are likely to be sick in the future. If that is true, then the concepts of health, disease, illness and sickness need to be tweaked accordingly. A disease, which is commonly intended as a biological dysfunction, might be equal to a genetical predisposition, but only if the biological dysfunction is already there. Healthy-ill individuals should not be patients, in the sense that they are not ill; however, the implications that a predisposition carries with it might as well count as an illness, as in the circumstances pointed out above. Finally, social institutions may decide to take into consideration genetic profiles to label a citizen as sick, thus providing or denying access to treatments.

The fact that health is going to be somehow detached from exterior symptoms is also quite important, because it leads us to a sort of 'de-temporalization' of health itself. We could distinguish between two different types of health: the present one and the future one. The latter is, by definition, not yet existent, but it might be inferred thanks to genetic tests. So some of the relevant questions to ask are: which health do we want to take care of? Which one is the most important for us, as individuals/patients, and which one should be taken into account by healthcare professionals? Arguably, one of the goals of medicine is not only to cure, but also to preserve health. However, in the context of personalized medicine it has yet to be precisely defined which health we really want to maintain.

To conclude, personalized medicine poses a whole range of new challenges for philosophy of medicine. It might also be asked whether all those risks we are able to predict can actually be managed by medicine,

and whether there is a threshold over which treatments are less effective or even completely ineffective⁴⁶. Is there any risk that, by focusing so much on the molecular level we are missing the bigger picture? These questions are relevant in general and they are even more important as the COVID-19 crisis is on is showing us there are cases in which the big picture might be at least as important as – and maybe more – what we see through a focus lens. There is little doubt that biomedical research is going to explore more in depth the human organism, and consequently many advances in the field are going to be made; at the same time, however, I believe that it is important to bear in mind that the molecular precision should only be a part of a more comprehensive idea of clinical medicine.

⁴⁶ Cf. J.W. Mold *et al.*, *The Law of Diminishing Returns in Clinical Medicine: How Much Risk Reduction is Enough?*, “The Journal of the American Board of Family Medicine”, XXIII, 3, 2010, pp. 371-375.

“The bad habit of wandering”: Morgan, Osborn e il problema della causalità evolutiva fra genetica e paleontologia

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Abstract: According to George Gaylord Simpson, during the first decades of the twentieth century the debate on evolution was featured by a deep contrast between genetics and palaeontology. Simpson stressed that, while geneticists said that palaeontology “had no further contributions to make to biology”, palaeontologists felt that geneticists were studying organisms under “unnatural conditions”. These statements recall one of the most interesting debates in the history of American biology, that between Thomas Hunt Morgan and Henry Fairfield Osborn. This paper aims at analysing such contention by highlighting how it was due not merely to an irreducible gap between genetics and palaeontology, but rather to Osborn’s controversial attempt to integrate orthogenesis and Mendelism. I argue that Osborn’s synthesis between genetics and palaeontology questions the much-discussed transition from ‘old’ to ‘new biology’ as well as the narrative of a clear break between orthogenetic and synthetic paleontology.

Keywords: sperimentalismo; paleontologia; ortogenesi; Sintesi Moderna

1. Introduzione

Per il paleontologo George Gaylord Simpson, fra i principali ‘architetti’ della cosiddetta Sintesi Moderna, l’estensione del modello evolutivistico darwiniano-popolazionale alla macroevoluzione rappresentò un traguardo doppiamente necessario. Da un lato, la crescente consapevolezza della complessità dei fenomeni evolutivi aveva reso ormai indispensabile la collaborazione fra genetisti, zoologi e paleontologi; dall’altro, la ricerca di un approccio integrato fra livelli d’osservazione, problemi e metodologie di ricerca avrebbe sanato una frattura nella biologia post-darwiniana: quella fra genetica e paleontologia.

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Negli anni di formazione a Yale e al Museo di Storia Naturale di New York, Simpson aveva vissuto in prima persona le controversie fra paleontologi e genetisti dei primi decenni del ventesimo secolo. Nell'introduzione di *Tempo and Mode in Evolution* (1944) scrisse:

Not long ago paleontologists felt that a geneticist was a person who shut himself in a room, pulled down the shades, watched small flies disporting themselves in milk bottles, and thought that he was studying nature. A pursuit so removed from the realities of life, they said, had no significance for the true biologist. On the other hand, the geneticists said that paleontology had no further contributions to make to biology, that its only point had been the completed demonstration of the truth of evolution, and that it was a subject too purely descriptive to merit the name 'science'.¹

Se per i paleontologi del tempo il lavoro degli sperimentalisti rischiava di ridimensionare lo studio della natura a pratiche da laboratorio 'artificiose' e 'innaturali', per i genetisti la paleontologia non poteva accedere allo studio delle cause del cambiamento evolutivo. Ai loro occhi, commentava Simpson servendosi di un'analogia tremendamente evocativa, il paleontologo non era diverso da chi, desideroso di comprendere il motore a combustione, si limitava a osservare le automobili sfrecciare da un angolo della strada².

È molto probabile che Simpson avesse in mente uno dei confronti più rilevanti della biologia americana del primo Novecento, quello fra il genetista Thomas Hunt Morgan e il paleontologo Henry Fairfield Osborn, presidente del Museo di Storia Naturale di New York dal 1908 al 1933. Per anni, Morgan e Osborn dibatterono sulla natura epistemologica della spiegazione paleontologica e sul valore dell'approccio microscopico-sperimentale nello studio delle cause dell'evoluzione. Le critiche di Morgan alla paleontologia 'speculativa', e più in generale i dati provenienti dallo studio sperimentale dei fenomeni ereditari, costrinsero Osborn a elaborare compromessi teorici, evidenziare i rischi dello specialismo e, al tempo stesso, rivendicare l'autonomia della propria disciplina. Negli ultimi anni della sua carriera, lui stesso definì la sua sintesi fra genetica e paleontologia come fallimentare³. Il presente saggio intende tuttavia mostrare come, nonostante i suoi limiti, lo sforzo teorico di Osborn rispecchiasse anzitutto il bisogno di ovviare alla crescente compartimentazione degli studi bio-

¹ G. Gaylord Simpson, *Tempo and Mode in Evolution*, Columbia University Press, New York 1944, p. XV.

² *Ibidem*.

³ H. Fairfield Osborn, *Fifty-Two Years of Research, Observation and Publication 1877-1929*, Charles Scribner's Sons, New York 1930, p. 73.

logici che, negli anni '40, avrebbe motivato la sintesi fra genetica di popolazione e paleontologia.

2. Mutazionismo e ortogenesi fra 'vecchia' e 'nuova' biologia

La nascita della cosiddetta 'teoria mutazionista' è stata generalmente ricondotta al proliferare degli studi sperimentali sull'ibridazione fra diciannovesimo e ventesimo secolo⁴. Prima ancora della riscoperta delle ricerche di Gregor Mendel, numerosi autori, molti dei quali botanici, avevano maturato una visione discontinuista della variabilità, che, si è spesso sottolineato in letteratura, era stata accompagnata da un generale scetticismo verso la teoria darwiniana⁵. Già con *Hereditary Genius* (1869) e *Natural Inheritance* (1889), Francis Galton, cugino di Darwin da parte paterna, aveva criticato la teoria darwiniana proponendo un'interpretazione discontinuista delle variazioni. Servendosi dei suoi studi sui fenomeni di correlazione e regressione statistica, Galton constatò che, a ogni generazione, le minime variazioni conservate dalla selezione naturale tendevano a regredire al valore medio. Ne conseguiva che le uniche variazioni rilevanti dovevano essere veri e propri salti (*sports*) al livello germinale. Negli anni '90, questa linea interpretativa fu ulteriormente elaborata dal biologo inglese William Bateson, che, in *Materials for the Study of Variation* (1894), avanzò l'ipotesi secondo cui la discontinuità fra le specie poteva rispecchiare fenomeni variazionali altrettanto discreti.

Più che come un rifiuto categorico della selezione naturale, la critica mutazionista si configurò come una replica alla concezione darwiniana della variabilità, in particolare all'idea che l'ambiente potesse provocare fluttuazioni ereditarie⁶. In questo scenario, la riscoperta delle leggi di Mendel ebbe un impatto propulsivo sul lavoro di molti autori, determinando una delle più profonde "rotture epistemologiche" delle scienze del vivente del Novecento⁷. Fu in particolare il lavoro del botanico olandese

⁴ S. Müller-Wille, H.-J. Rheinberger, *A Cultural History of Heredity*, University of Chicago Press, Chicago 2012.

⁵ W. Ball Provine, *The Origins of Theoretical Population Genetics*, University of Chicago Press, Chicago 1971; E. Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance*, Harvard University Press, Cambridge 1982.

⁶ S. Arlin, C. Kele, *Mendelian-Mutationism: The Forgotten Evolutionary Synthesis*, "Journal of the History of Biology", 47, 2014, pp. 501-546.

⁷ S. Bachelard, *Epistemologie et Histoire des Sciences*, "Revue de Synthèse", 3ème serie, nn. 49/52, Editions Albin Michel, Paris 1968, pp. 39-51.

Hugo De Vries a giocare un ruolo decisivo nella diffusione delle tesi mendeliane. Venuto a conoscenza degli esperimenti di Mendel quasi contemporaneamente ai biologi Carl Correns ed Erich von Tschermak, De Vries introdusse la nozione di “mutazione” in *Die Mutationstheorie* (1901-1903), spiegando il cambiamento evolutivo come effetto di salti mutazionali in grado di generare sotto-specie. Solo in un secondo momento avrebbe potuto agire su di esse la selezione naturale, principio regolativo in grado di esercitare una “forza negativa”⁸.

L'opera di De Vries, che al tempo fu definita dallo zoologo Frank Collins Baker come la più importante svolta in biologia dalla pubblicazione dell'*Origin of Species*⁹, ebbe certamente il merito di diffondere i principi della genetica mendeliana. Per coloro che avevano già abbracciato la concezione discontinuista della variabilità, questi posero nuove fondamenta su cui ricostruire l'intero discorso sull'ereditarietà e l'evoluzione. Ciò avvenne tuttavia lungo itinerari diversi. Bateson, ad esempio, divenne in breve tempo uno dei più autorevoli difensori del mendelismo¹⁰, opponendosi alle critiche sollevate dalla cosiddetta scuola biometrica anglosassone, orientata verso una spiegazione continuista della variabilità. L'embriologo americano Thomas Hunt Morgan passò invece da un dichiarato scetticismo a un'entusiastica accettazione. Nella prima fase della sua carriera alla Columbia University, Morgan aveva riscontrato nel mendelismo un vizio epistemologico comune a molte impostazioni teoriche, ovvero il presupporre l'esistenza di processi e unità ereditarie non verificati. “In the modern Mendelism” scrisse nel 1909 “facts are being transformed into factors at a rapid date”¹¹. Ma circa un anno dopo, divenne uno dei massimi teorici internazionali del mendelismo grazie ai suoi celebri esperimenti sulla *Drosophila melanogaster*, con cui poté dimostrare la correttezza della teoria cromosomica di Sutton-Boveri, ma soprattutto come l'espressione fenotipica di determinati caratteri (il tratto recessivo ‘occhi bianchi’ nel caso dei moscerini) fosse legata proprio alla collocazione cromosomica dei fattori mendeliani e, nel caso particolare, al sesso.

⁸ P. Bowler, *Hugo De Vries and Thomas Hunt Morgan: The Mutation Theory and the Spirit of Darwinism*, “Annals of Science”, 35, 1, 1978, pp. 55-73; S.J. Gould, *The Structure of Evolutionary Theory*, 2002; Telmo Pievani (a cura di), *La struttura della teoria dell'evoluzione*, Codice edizioni, Torino 2003, p. 186.

⁹ F. Collins Baker, *Application of De Vries's Mutation Theory to the Mollusca*, “The American Naturalist”, 40, 473, 1906, p. 327; G.E. Allen, *Hugo de Vries and the Reception of the “Mutation Theory”*, “Journal of the History of Biology”, 2, 1, 1969, pp. 55-87.

¹⁰ W. Bateson, *Mendel's Principles of Heredity: a Defense*, Cambridge University Press, Cambridge 1909.

¹¹ T.H. Morgan, *American Breeders Association Reports*, 5, 1909, p. 365.

L'evidenza sperimentale di micro-cambiamenti fenotipici in specie già esistenti comportò una svolta nel rapporto fra Morgan e l'evoluzionismo¹². Per anni egli aveva criticato il funzionalismo e l'adattazionismo darwiniano, sostenendo che le mutazioni fossero in grado di dirigere da sole il corso dell'evoluzione: i caratteri adattativi e non adattativi degli organismi sembravano darsi in un rapporto bilanciato, il che mostrava la scarsa incidenza della selezione naturale¹³. Dal 1910, e soprattutto in *Critique of the Theory of Evolution* (1916), Morgan rivalutò la selezione come principio regolatore della distribuzione di mutazioni all'interno di una popolazione. Pur non avendo alcun potere creativo¹⁴, il meccanismo darwiniano risultava comunque in grado di accumulare variazioni fenotipiche vantaggiose:

Natural selection [...] means both the increase in the number of individuals that results after a beneficial mutation has occurred (owing the ability of living matter to propagate) and also that this preponderance of certain kinds of individuals in a population makes some further results more probable than others. More than this, natural selection cannot mean, if factors are fixed and not changed by selection¹⁵.

Secondo lo storico Garland Allen, la svolta epistemologica segnata dai lavori di Bateson, De Vries e Morgan fu accomunata anzitutto dal rifiuto della biologia speculativa. Già nel 1901, il biologo Edmund Beecher Wilson, collega di Morgan alla Columbia e autore di *The Cell in Development and Inheritance* (1896), aveva rilevato come gli studi fondati sulla morfologia comparata avessero ormai condotto il discorso biologico in un vicolo cieco fatto di speculazioni e problemi insolubili. Per tale ragione, era necessario seguire linee di ricerca più feconde come la fisiologia e la "morfologia sperimentale"¹⁶. Allen ha individuato i prodromi di questa transizione nel successo ottenuto dall'embriologia meccanicistica (*Entwicklungsmechanik*) di Wilhelm Roux. A differenza di autori come Ernst Haeckel, Edward Drinker Cope e Alpheus Hyatt, i teorici della legge biogenetica, per Roux spiegare lo sviluppo non significava considerare la

¹² P. Bowler, *Hugo De Vries and Thomas Hunt Morgan*, cit., p. 70; Id., *The Eclipse of Darwinism. Anti-Darwinian Evolution Theories in the Decades around 1900*, The Johns Hopkins University Press, Baltimore 1983, p. 204.

¹³ T.H. Morgan, *Evolution and Adaptation*, Macmillan Company, New York 1903, p. 464.

¹⁴ T.H. Morgan, *A Critique of the Theory of Evolution*, Princeton University Press, Princeton 1916, p. 154.

¹⁵ Ivi, p. 94.

¹⁶ E. Beecher Wilson, *Aims and Methods of Study in Natural History*, "Science", 13, 314, 1901, p. 17.

storia filogenetica come la causa degli stadi embrionali, ma analizzare le cause fisico-chimiche del processo di differenziazione ontogenetica¹⁷. Negli Stati Uniti, l'opera di Roux trovò un ampio spazio di discussione nel Marine Biological Laboratory di Woods Hole (Massachusetts), inaugurato nel 1888 sul modello della Stazione Zoologica di Napoli. Fu qui che Thomas Hunt Morgan si avvicinò all'embriologia sperimentale, divenendone uno dei più importanti rappresentanti in America.

Prima ancora della diffusione del mendelismo, dunque, l'approccio microscopico-sperimentale aveva condotto vari scienziati ad abbandonare la biologia di coloro che, scriveva Bateson nel 1894, continuavano a propinare alberi filogenetici senza dati convincenti¹⁸. "Morphology" affermò alcuni anni dopo il genetista Wilhelm Johannsen "supported by the huge collections of the museums has operated with 'phenotypes' in phylogenetic speculation. It is thus a science of phenotypes and is not of value in genetic inquiries"¹⁹. Questo slittamento epistemologico è stato spesso considerato foriero di riduzionismo. Per un autore come Morgan, scrisse ad esempio Theodosius Dobzhansky nel 1974, ogni approccio alla biologia che non fosse strettamente sperimentalista non meritava alcuna attenzione. "Naturalista" era per lui una parola quasi dispregiativa, l'antonimo di 'scienziato', e questo perché "la biologia doveva essere rigorosamente riduzionista. I fenomeni biologici dovevano essere spiegati nei termini della chimica e della fisica"²⁰.

Il riduzionismo di Morgan è stato oggetto di numerose discussioni da cui emerge un quadro tutt'altro che uniforme. Si è scritto che l'embriologo e i suoi collaboratori della Columbia ridussero la "causazione" alla semplice descrizione di pattern "concomitanti". Per Allen, Morgan fu portavoce di un riduzionismo metodologico, ma non si limitò mai a considerare l'organismo come un "sacco di molecole". Per lui, la nozione di 'gene' rappresentò anzitutto uno strumento teorico²¹. La sua avversione al

¹⁷ G.E. Allen, *Life Science in the Twentieth Century*, Cambridge University Press, Cambridge 1978, p. 34; S. Caianiello, *Immagini dello sviluppo da Gould a evo-devo*, in Id. (a cura di), *Da Gould a evo-devo. Percorsi storici e teorici*, Filosofia e Saperi 6, CNR Edizioni, Roma 2014, p. 64.

¹⁸ W. Bateson, *Materials for the Study of Variation*, Macmillan and Co., London 1894, p. V.

¹⁹ W. Johannsen, *The Genotype Conception of Heredity*, "The American Naturalist", XLV, 1911, p. 134.

²⁰ S.G. Gould, *The Structure*, cit., p. 664.

²¹ R. Falk, *Genetic Analysis*, in M. Matten, C. Stephens (eds.), *Handbook of the Philosophy of Science: Philosophy of Biology*, Elsevier, Amsterdam 2007, pp. 249-308; G.E. Allen, *Thomas Hunt Morgan: The Man and his Science*, Princeton University Press, Princeton 1978, p. 328; G. Frezza, M. Capocci, *Thomas Hunt Morgan and the Invisible Gene: the Right Tool for the Job*,

naturalismo ci sembra dunque comprensibile proprio alla luce del valore epistemologico che egli attribuì alla sperimentazione quantitativa: “biology, which not long ago was purely descriptive and speculative, has begun to adopt the methods of exact sciences, recognizing that for permanent progress not only experiments are required but quantitative experiments”²².

Per i paleontologi che si erano formati fra gli anni '70 e '80, affermazioni di questo tipo dovettero suonare non solo come provocatorie, ma come i segni di un'emarginazione scientifica e istituzionale. Dopotutto, ha sottolineato Ronald Rainger, fra i due secoli la paleontologia trovò sempre meno spazio nei dipartimenti di biologia²³. Specialmente in America, dove la paleontologia aveva contribuito all'emancipazione della scienza americana grazie a figure come Joseph Leidy, Othniel Marsh e Cope, la svolta sperimentalista innescò un acceso dibattito. Uno di questi fu proprio alla Columbia University dove, fra il 1908 e il 1910, Morgan condusse i suoi esperimenti sul moscerino della frutta. Paradossalmente, chi favorì l'inserimento di Morgan nel prestigioso college di New York fu colui che in seguito ne avrebbe più criticato l'operato, ovvero il paleontologo Henry Fairfield Osborn, al tempo direttore del dipartimento di biologia della Columbia.

Osborn fece il possibile per assicurarsi il giovane e talentoso studioso. Nel 1903, annunciò al consiglio della Columbia di essere persino disposto a decurtare il proprio stipendio pur di assumere Morgan, che, l'anno successivo, fu nominato professore di 'zoologia sperimentale', posizione mantenuta fino al 1928. Le ragioni che spinsero Osborn a favorire l'inserimento di Morgan alla Columbia sono state sviscerate da diversi storici. Alcuni hanno suggerito che il paleontologo vide in Morgan non solo una figura di alto spessore scientifico per il suo dipartimento, ma un possibile alleato nella lotta all'iperselezionismo neo-darwiniano²⁴.

Osborn si era avvicinato al dibattito evoluzionistico come sostenitore della teoria neo-lamarckiana insieme ai paleontologi americani Cope, Alpheus Hyatt, John Adam Ryder e Alpheus Packard. L'ordine mostrato

“History and Philosophy of the Life Sciences”, 20, 31, 2018, DOI: 10.1007/s40656-018-0196-z.

²² T.H. Morgan, *The Physical Basis of Heredity*, Lippincott Company, Philadelphia 1919, p. 5.

²³ R. Rainger, *Vertebrate Paleontology as Biology: Henry Fairfield Osborn and the American Museum of Natural History*, in R. Rainger, K. Benson, J. Maienschein (eds.), *The American Development of Biology*, University of Pennsylvania Press, Philadelphia 1988, p. 220.

²⁴ B. Regal, *Henry Fairfield Osborn. Race and the Search for the Origins of Man*, Ashgate, Aldershot 2002, p. 73.

dalle sequenze fossili e l'origine polifiletica di numerosi gruppi tassonomici testimoniavano, ai suoi occhi, il graduale adattamento meccanico delle strutture ossee a nuove circostanze ambientali e abitudini alimentari. Sottoposte a pressioni ambientali simili, specie diverse avevano sviluppato strutture analoghe tramite l'uso e il disuso delle parti, trasmettendo i caratteri acquisiti alla discendenza. Dal 1895, però, Osborn rimodulò la propria teoria spinto dal crescente discredito generatosi intorno all'ipotesi dell'eredità dei caratteri acquisiti. Il suo sguardo vigile sul dibattito coevo e, soprattutto, l'idea che la selezione naturale non potesse spiegare la direzionalità delle sequenze fossili, portò Osborn a elaborare una teoria ortogenetica basata sul principio di variazione "potenziale". Negli ultimi anni della sua carriera, ribattezzò tale teoria "aristogenesi":

Aristogenesis is a creative process from the geneplasm of entirely new germinal biomechanisms; the process is continuous, gradual, direct, definite in the direction of future adaptation. In time contrast to alloiometrons, which appear to be immediate and more or less temporal adaptive reactions to new habits, aristogenes are secular, appearing very slowly in the course of long periods of geologic time. Lines of ordinal, family, generic and specific descent may be distinguished by the potentiality of certain new geneplasmic aristogenes.²⁵

Come si evince da questo passaggio, per Osborn la macroevoluzione consisteva di due fasi distinte. In un primo momento, la suddivisione di una popolazione in aree diverse poteva determinare, ad esempio, la fluttuazione delle proporzioni craniche. Le modificazioni conseguenti, dette "allometrie", provocavano una differenziazione biogeografica che Osborn chiamò "radiazione adattativa". Tuttavia, la storia evolutiva di molti mammiferi mostrava che specie ormai separate geograficamente avevano sviluppato gli stessi "neomorfi" (una nuova cuspide nei denti o un rudimento di corno). Una volta esclusa l'ipotesi dell'adattamento meccanico, per spiegare questo fenomeno Osborn suppose che, in circostanze ambientali simili, il materiale germinale condiviso dai discendenti delle specie radiate rispondeva all'ambiente producendo le medesime variazioni ("rettigradazioni" o "aristogeni"). La macroevoluzione avveniva dunque in modo ortogenetico: a seguito di una prima divergenza, i rami filogenetici si trasformavano in linee parallele²⁶.

Osborn fu costretto ad ammettere la sua ignoranza rispetto alle cause

²⁵ H.F. Osborn, *Aristogenesis, the Creative Principle in the Origin of Species*, "The American Naturalist", 68, 716, 1934, p. 210.

²⁶ H.F. Osborn, *Homoplasy as a Law of Latent or Potential Homology*, "The American Naturalist", 36, 424, 1902, pp. 259-271.

della variazione aristogenetica: "we know how these aristogenes arise, but we do not know why they arise"²⁷. Dietro l'elaborazione di questa tesi vi fu tuttavia un percorso lungo e turbolento, ed è verosimile che egli vide in Thomas Hunt Morgan, almeno inizialmente, un potenziale alleato. Dopotutto, proprio nel 1903, l'anno in cui Osborn si spese per assumere Morgan alla Columbia, questi aveva avanzato dure critiche alla selezione naturale in *Evolution and Adaptation*. Col definirsi del programma di ricerca di Morgan, però, fra i due si generò una profonda divergenza che, in pochi anni, si tradusse in una disputa personale. Furono in particolare l'approccio di Osborn e i suoi tentativi di escogitare compromessi fra ortogenesi e genetica mendeliana a inquietare il genetista, il quale, a distanza di pochi anni dal suo ingresso a Columbia, iniziò ad esprimersi nei confronti del collega esattamente nei termini rievocati da Simpson nell'introduzione di *Tempo and Mode in Evolution*.

3. Osborn e la ricerca di un compromesso teorico fra mendelismo e ortogenesi

Secondo Rainger, Osborn portò avanti una critica indifferenziata alla genetica per tutta la sua carriera²⁸. Tuttavia, a differenza di altri colleghi²⁹, egli mostrò una spiccata propensione al confronto, il cui obiettivo fu quello di rivendicare il valore di un approccio olistico alla biologia evoluzionistica.

Furono almeno tre i temi attorno ai quali orbitò la riflessione di Osborn sulla genetica: il problema della direzionalità delle mutazioni, la discontinuità variazionale e, infine, la riconducibilità dei fenotipi fossili a quelle unità ereditarie definite per la prima volta da Johannsen come "geni"³⁰. I risultati di questa riflessione furono esposti da Osborn in due occasioni: la celebrazione americana del centesimo anniversario della nascita di Charles Darwin tenutasi a Baltimora il 1° gennaio del 1909 e l'in-

²⁷ H.F. Osborn, *Aristogenesis*, cit., p. 210.

²⁸ R. Rainger, *An Agenda for Antiquity: Henry Fairfield Osborn and Vertebrate Paleontology at the American Museum of Natural History, 1890-1935*, The University of Alabama Press, Tuscaloosa and London 1991, pp. 132-139.

²⁹ Il paleontologo e teorico dell'ortogenesi William B. Scott ammise ad esempio di non aver mai trovato ragioni valide per riesaminare le sue teorie alla luce del mendelismo, G.G. Simpson, *Biographical Memoir of William Berryman Scott, 1858-1947*, National Academy of Sciences Biographical Memoirs, XXV, 1948, p. 190.

³⁰ W. Johannsen, *The Genotype Conception*, cit., p. 132.

contro alla Harvey Society di New York del 20 gennaio 1912. In entrambe le conferenze, Osborn commentò pubblicamente lo stato d'avanzamento delle scienze biologiche evidenziando la necessità di preservare un approccio plurale allo studio dell'evoluzione. Non solo manifestò tutta la sua preoccupazione per le sorti della paleontologia, sempre più relegata allo status di scienza dei musei, ma evidenziò i rischi della separazione fra naturalismo e sperimentalismo. Ridurre lo studio del vivente al lavoro di laboratorio rappresentava per Osborn un affronto alla complessità dei sistemi biologici. Egli senza dubbio comprendeva il valore della ricerca sperimentale, ma intravedeva in essa la pericolosa tendenza a sopravvalutare risultati ottenuti in condizioni d'osservazione artificiali. La teoria mutazionista dell'evoluzione, estendendo all'intero regno animale quanto osservato in laboratorio, palesava lo stesso limite epistemologico. In uno scambio privato con Morgan risalente alla primavera del 1910, Osborn aveva del resto confessato le sue perplessità sul significato delle mutazioni nella storia evolutiva dei mammiferi: "Mutation plays a relatively small part in the evolution of mammals"³¹.

L'eccessiva fiducia nello sperimentalismo aveva condotto in errore Bateson, che, in *Materials for the Study of Variation* (1894), aveva elencato una serie di caratteri somatici discontinui nella storia dei mammiferi senza tuttavia curarsi del loro reale significato filogenetico. Servendosi delle critiche del suo collega William D. Matthew, Osborn commentò:

Bateson cites 323 cases of discontinuity in vertebrae, teeth and skull. Of these 286 are teratological, or reversional, and have absolutely no significance in evolution; ten cases supernumerary (or fourth molar) teeth are possibly significant because among the mammals there are a few genera with fourth molars which may possibly have arisen by saltation. There remain only thirty-seven cases which may be ranked as "probably significant", and these are the meristic additions or reductions of vertebrae in the spinal column, significant because of the well-known variations in the vertebral formulae of different mammals, and secondly because vertebrae can be added or subtracted only discontinuously.³²

Un tale errore nasceva da un fraintendimento comune a chi osservava il dato biologico in laboratorio: confondere tratti filogeneticamente significativi e caratteri transitori. La fragilità dello sperimentalismo risiedeva dunque in ciò che Osborn, non senza una certa dose di retorica, definì

³¹ B. Regal, *Henry Fairfield Osborn*, cit., p. 73.

³² H.F. Osborn, *The Continuous Origin of Certain Unit Characters as Observed by a Paleontologist (Part I)*, "The American Naturalist", 46, 544, 1912, p. 194.

"mortalità dell'osservazione non-paleontologica"³³. Solo il paleontologo poteva deliberare sul dato sperimentale. "Paleontology is the acid test" ribadì alcuni anni dopo "*paleontology is evolution*"³⁴.

Messa alla prova dal paleontologo, la tesi mutazionista mostrava almeno due punti deboli. In primo luogo, il materiale fossile accumulato nei decenni successivi alla pubblicazione dell'*Origin of Species* falsificava, secondo Osborn, l'interpretazione a-direzionale delle variazioni sostenuta sia dai saltazionisti che dal darwinismo classico. In secondo luogo, le serie fossili mostravano una modificazione graduale delle strutture difficilmente conciliabile con la tesi saltazionista. Le macrovariazioni potevano essere osservate nelle piante o in poche altre specie esistenti, ma non si poteva dire altrettanto dei fossili: "Over a half century of anatomical research among mammals has failed to demonstrate in a state of nature the sudden origin of a single new progressive character which has become fixed in the race"³⁵. Se vi era discontinuità nei fossili, questa, come già sottolineato da Lyell e Darwin, andava attribuita all'imperfezione della documentazione paleontologica e non a mutazioni in grado di provocare salti evolutivi.

Se, almeno su questi due punti, la paleontologia sembrava confutare il mutazionismo, per Osborn i fossili suffragavano il vero elemento rivoluzionario della teoria mendeliana: la concezione dell'ereditarietà in termini di unità discrete. Per mostrare ciò, era sufficiente analizzare i dati paleontologici nei termini usati dai genetisti. I fenotipi studiati dai paleontologi, ovvero i caratteri allometrici e i "neomorfi", seguivano le leggi mendeliane? Pur essendo evoluti gradualmente, questi cambiamenti corrispondevano a unità ereditarie discrete? E quale grado di divisibilità presentavano nei casi d'ibridazione? Se si esaminavano le allometrie craniche nelle progenie dell'incrocio fra uomini brachicefali e dolicocefali, illustrò Osborn nel suo intervento alla Harvey Society, si riscontrava in effetti un mosaico di tratti somatici, e non una mescolanza. Nella generazione risultante, tratti dolicocefali e brachicefali si alternavano all'interno dello stesso cranio³⁶.

³³ H.F. Osborn, *Darwin and Paleontology*, in *Fifty years of Darwinism. Modern Aspects in Evolution*, Henry Holt and Company, New York 1909, p. 228.

³⁴ H.F. Osborn, *The Nine Principles of Evolution Revealed by Paleontology*, "The American Naturalist", 66, 702, 1932, p. 56.

³⁵ H.F. Osborn, *The Continuous Origin (Part I)*, cit., p. 206.

³⁶ H.F. Osborn, *The Continuous Origin of Certain Unit Characters as Observed by a Paleontologist (Part II)*, "The American Naturalist", 46, 545, 1912, pp. 249-278; Id., *Origin of Single Characters as Observed in Fossil and Living Animals and Plants*, "The American Naturalist", 49,

Anche le rettigradazioni sembravano manifestarsi seguendo uno schema mendeliano. Il *'pli caballin'*, una piega dello smalto caratteristica dei denti del cavallo, svaniva completamente nel mulo, l'incrocio fra cavallo e asino. Nel cranio dei muli i caratteri del cavallo e dell'asino erano inoltre facilmente distinguibili, il che dimostrava come anche tratti acquisiti gradualmente durante la filogenesi fossero il risultato della distribuzione di unità genetiche discrete. La discontinuità germinale, su cui i genetisti insistevano in modo sempre più significativo, non implicava salti evolutivi. Allometroni e rettigradazioni potevano tuttavia essere ricondotti a unità separate geneticamente: "they split up into a larger and smaller group or units, some into partially blending units, others into absolutely distinct or non-blending unit; finally that at least in the first cross they exhibit dominance"³⁷. Ciascun carattere, chiariva però Osborn, era il risultato di una complessa interazione causale:

If only one of these 'determiners' should change the character of the horn would change, or the horns might be altogether. Thus the germinal correlation of 'determiners' to produce what appears as a single character to the zoologist and paleontologist is visibly represented in the bodily correlation of the horn with a very elaborate offensive and defensive mechanism including all the bony and muscular characters necessary to operate the horn effectively, as well as the psychic desires and impulses to use the horn. We thus have a vast array of internal and external, of structural and functional correlations with this single character, the horn.³⁸

La nascita di rettigradazioni e allometroni dipendeva dalla correlazione fra fattori diversi. Richiamando la massima di John Stuart Mill "the cause is the sum total of the conditions, positive and negative, taken together", per Osborn eredità, sviluppo, ambiente e selezione naturale interagivano costantemente nell'evoluzione biologica³⁹. Le difficoltà che avevano incontrato gli evoluzionisti nel corso del dibattito post-darwiniano nasceva-

580, 1915, pp. 193-239. Osborn si rifece agli studi degli antropologi Franz Boas, Elliot Smith e Aleš Hrdlička. Cruciale fu ad esempio la risposta arrivatagli da Boas nell'aprile del 1911: "Among European peoples head proportions are considered among the most stable and permanent of all characteristics. In intermarriage of 'dolichocephalic' and 'brachycephalic' individuals the children do not form a blend between their parents but inherit either the dolichocephalic or brachycephalic head form", Id., *The Continuous Origin (Part II)*, cit., p. 260.

³⁷ Ivi, p. 252.

³⁸ H.F. Osborn, *Origin of Single Characters*, cit., p. 233.

³⁹ H.F. Osborn, *Tetraplasy: the Four Inseparable Factors of Evolution*, "The Journal of The Academy of Natural Sciences of Philadelphia", 15, 1912, pp. 275-309; John Stuart Mill, *A System of Logic, Ratiocinative and Inductive*, 1, III^a, John Parker, West Strand, London 1843, p. 366.

no proprio dalla dissociazione di questi fattori o dal ridurre la spiegazione dei cambiamenti evolutivi a uno solo di essi.

Direzionalità e gradualismo rappresentavano dunque gli aspetti principali del modello ortogenetico di Osborn. I fossili smentivano la concezione a-direzionale delle mutazioni e l'ipotesi che la formazione di nuove specie avvenisse tramite salti evolutivi. Al tempo stesso, però, corroboravano le leggi di Mendel, dimostrando che, nei casi d'ibridazione, numerosi caratteri ossei erano distribuiti in modo proporzionale. La genetica aveva rivitalizzato una dicotomia che dall'epoca classica aveva accompagnato la riflessione sulla natura, quella fra contingenza e necessità, fra "caso" e "legge". La paleontologia poteva dare il suo contributo: mettere alla prova il dato sperimentale e screditare l'immagine antifeudalistica dell'evoluzione caldeggiata dai mutazionisti, confermando l'intuizione aristotelica secondo cui la natura produrrebbe "solo quelle cose che, essendo mosse continuamente da un certo principio contenuto in esse, arrivano a un certo fine"⁴⁰.

4. *Le cause dell'evoluzione e il 'vizio della speculazione'*

Per Morgan, i lavori di Osborn rappresentavano un pessimo esempio di pratica scientifica. Come scrisse in *A Critique of the Theory of Evolution* (1916), i paleontologi che traevano leggi e principi nomotetici dai fossili si macchiavano di quel "bad habit of wandering" che tanto connotava la morfologia ottocentesca. Conoscere l'ordine della comparsa di date strutture ossee non forniva alcun indizio sulla loro origine. L'unico modo per comprendere le cause dell'evoluzione era analizzarne il materiale di partenza, ovvero le mutazioni:

With this unrivalled material and splendid series of gradations, palaeontology has constructed many stages in the past history of the globe. But palaeontologists have sometimes gone beyond this descriptive phase of the subject and have attempted to formulate the "causes", "laws" and "principles" that have led to the development of their series. [...] The geneticist says to the palaeontologist, since you do not know, and from the nature of your case can never know, whether your differences are due to one change or to a thousand, you cannot with certainty tell us anything about the hereditary units which have made the process of evolution possible. And without this knowledge there can be no understanding of the causes of evolution.⁴¹

⁴⁰ H.F. Osborn, *The Continuous Origin (Part II)*, cit., p. 277.

⁴¹ T.H. Morgan, *A Critique*, cit., pp. 25-27.

Benché Morgan non facesse direttamente riferimento a Osborn in questi passaggi, non è difficile immaginare chi fosse il vero bersaglio delle sue critiche. Proprio nel 1916, i due avevano iniziato a dibattere sulla capacità euristica dell'approccio sperimentalista. I risultati degli esperimenti sulle drosofile, Osborn commentò in una lettera inviata a Morgan il 3 agosto, dicevano ben poco sulle cause dell'evoluzione, essendo frutto di "condizioni innaturali"⁴². Obiezioni di questo tipo, replicò Morgan, dovevano essere mosse anche agli astronomi che studiavano le stelle con lo spettroscopio, ai fisici che studiavano la corrente elettrica con il galvanometro e a chiunque altro "torturasse" la natura con strumenti "artificiali". Più che dell'antonimia fra indagine "naturale" e "innaturale", la scienza moderna doveva preoccuparsi di quella fra dati verificabili e speculazioni "sfrenate"⁴³.

Nel 1917, la polemica si accese definitivamente con la pubblicazione da parte di Osborn di *The Origin and Evolution of Life*, la sua trattazione di biologia teorica più ambiziosa. In realtà, il volume non presentò novità rilevanti sul piano teorico, ma introdusse un nuovo lessico con lo scopo di rinforzare la sua critica al riduzionismo e promuovere una visione multifattoriale dell'evoluzione⁴⁴. L'organismo veniva ora definito come "un'arena di energia e materia" in rapporto dinamico con l'ambiente. Il materiale ereditario rappresentava "un centro distinto e altamente complesso di energia potenziale" che indirizzava lo sviluppo coordinandosi con le energie inorganiche del mondo esterno e con il contesto ecologico⁴⁵. Compito dell'evoluzionista era ricostruire l'interazione fra le "energie" ereditarie, ontogenetiche e ambientali, diffidando sia dei modelli "centripeti", che identificavano le cause dell'evoluzione nei fattori esterni all'organismo, sia da quelli "centrifughi", che riducevano il cambiamento evolutivo alle potenzialità intrinseche al germoplasma⁴⁶.

Nella prima sezione del volume, Osborn tentò di integrare all'interno della sua teoria ortogenetica le conoscenze emergenti dal campo della fisiologia e dallo studio del sistema endocrino. Le allometrie, cruciali come

⁴² B. Regal, *Henry Fairfield Osborn*, cit., p. 73.

⁴³ T.H. Morgan, *A Critique*, cit., pp. 84-85.

⁴⁴ "That life forms have reached their present stage through the operations of chance has been the opinion held by a great line of natural philosophers from Democritus and Empedocles to Darwin, and including Poulton, De Vries, Bateson, Morgan, Loeb and many others of our own day", H.F. Osborn, *The Origin and Evolution of Life*, Charles Scribner's Sons, New York 1917, p. 7.

⁴⁵ Ivi, p. XVI.

⁴⁶ Ivi, p. VIII, 19.

si è visto nelle fasi di divergenza filetica, potevano essere ricondotte al funzionamento dei catalizzatori chimici, in particolare agli “ormoni” e ai “caloni”, rispettivamente attribuiti alla funzione stimolante e inibitoria. Avvalendosi degli studi del fisiologo inglese Edward Albert Sharpey-Schafer, Osborn evidenziò che eventuali lesioni alla ghiandola pituitaria (ipofisi) potevano determinare una struttura corporea rachitica, eccessiva adiposità o sviluppo sessuale ritardato. Un suo funzionamento eccessivo avrebbe invece provocato il sovrasviluppo del cranio e degli arti. Il cambiamento allometrico era dunque strettamente connesso al funzionamento del sistema endocrino:

Of the chemical messengers produced by these glands some affect the growth of the entire organism, while other affect only certain parts of the organism; some arrest growth entirely, others stimulate growth at certain points only, and others again entirely change the proportions of certain parts of the body. [...] In other words, the regulation and balance resulting in the normal size and proportions of certain parts of the skeleton are dependent upon chemical messengers coming from these glands⁴⁷.

La storia della vita sulla Terra era, anzitutto, una storia di azioni e reazioni a più livelli. A ogni fenomeno, endogeno o esogeno, conseguiva sempre un processo di bilanciamento. Come un soldato in un esercito, l'evoluzione del singolo carattere avveniva in modo coordinato rispetto al resto dell'organismo⁴⁸. L'organizzazione della struttura scheletrica mostrava nitidamente la presenza di questi processi di regolazione. Riflettendo a distanza di anni su una delle sue ricostruzioni fossili più famose, quella del *Tyrannosaurus rex*⁴⁹, Osborn riconobbe che gli arti superiori atrofizzati di questo animale dimostravano l'esistenza di meccanismi di compensazione fra regioni e organi diversi. Gli stessi rapporti trofici erano regolati da un bilanciamento reciproco. All'evoluzione di determinate strutture nei predatori, corrispondevano adattamenti, corna e placche ossee ad esempio, nelle prede. Questo fenomeno, definito come “countervailing evolution”, rappresentava un principio universale nella storia della vita sulla Terra, individuabile fra lupi e cervi nell'emisfero boreale, fra leoni e antilopi in quello australe e nella stessa coevoluzione fra *Tyrannosaurus* e *Triceratops* durante il Cretaceo⁵⁰.

⁴⁷ Ivi, p. 75.

⁴⁸ Ivi, p. 275.

⁴⁹ I primi reperti di Tirannosauro furono rinvenuti da Barnum Brown fra il 1902 e il 1907 nel Montana. Osborn descrisse l'esemplare definendolo come “tyrant lizard king”.

⁵⁰ H.F. Osborn, *The Origin and Evolution of Life*, cit., p. 225.

L'accoglienza ricevuta da *The Origin and Evolution of Life* non fu delle migliori. Nonostante il successo ottenuto nel pubblico generalista, il volume suscitò critiche piuttosto dure da parte della comunità scientifica. Sia per il linguaggio che per i contenuti, il testo fu considerato un passo indietro rispetto al rinnovamento tecnico e metodologico apportato dalla biologia sperimentale⁵¹. Oltretutto, il problema dell'origine delle rettigrazioni, i veri cambiamenti progressivi nella filogenesi, non era stato chiarito. Osborn continuava a fornire risposte elusive, paragonando il loro stato di latenza nel germoplasma al principio di energia potenziale in fisica e affermando che la loro comparsa fosse dovuta a interazioni ignote⁵².

Morgan, che già da diversi anni era coinvolto nella disputa con il paleontologo, attaccò duramente il volume nell'inverno del 1917. Il 26 dicembre spedì a Osborn una lunga lettera di critica dettagliata, soprattutto dei capitoli in cui il paleontologo aveva azzardato una sintesi fra biochimica, genetica e paleontologia. Morgan divise la sua lettera in tre sezioni, partendo anzitutto da una valutazione epistemologica del lavoro del collega:

1. In the first place, when you say the 'causes of the evolution of life are as mysterious as the law of evolution is certain', it seems to me that you are not living up to expectation. I know, of course, that you use 'law' in the sense in which the chemist and the physicist does not use it, for I gather you mean only a sort of generalization when you speak of law or a strong personal opinion or bias, although at other times I think you use the expression as though it were an ultimate cause itself. For instance, on page XII of the preface you say: 'You may be compelled to regard the origin of evolution of life as an ultimate law like the law of gravitation which may be mathematically and physically defined but cannot be resolved into any causes'. I cannot but think that so long as the causes of evolution are admittedly unknown it is not possible to treat scientifically the process of evolution from the energy standpoint, however much one may be convinced that some day we may be able to do so.⁵³

Osborn non era all'altezza delle questioni trattate nella prefazione del volume. Pur ammettendo l'ignoranza delle cause dell'evoluzione, nulla legittimava il ricorso alla concezione 'energetica' caldeggiata dal paleontologo. Ancor più controverso era il ricorso alla dicotomia "law-chance":

⁵¹ Constance Areson Clark, *God or Gorilla: Images of Evolution in the Jazz Age (Medicine, Science, and Religion in Historical Context)*, The Johns Hopkins University Press, Baltimore 2008.

⁵² H.F. Osborn, *The Origin and Evolution of Life*, cit., p. 278.

⁵³ N. Reingold, *Jacques Loeb, the Scientist: His Papers and His Era*, in "Quarterly Journal of Current Acquisitions", 19, 3, 1962, p. 125.

2. On page 7 in the first chapter you say: 'In other words, in the origin and evolution of living things, does Nature make a departure from its previous orderly procedure and substitute chance for law?' This contrast between law and chance recurs in a number of places in the volume and is likely everywhere to mislead the reader who is not informed, as I know you to be, on the whole philosophical conception that lies back of these two words. From the energy point of view there is no such distinction between law and chance conceivable.⁵⁴

Come ha commentato Allen, Morgan sospettò che Osborn utilizzasse il termine "chance" per indicare una vera e propria assenza di cause, il che rischiava di condurre i lettori meno avveduti a un'interpretazione irrazionalistica dell'evoluzione⁵⁵. La dicotomia usata da Osborn era dunque pericolosa, poco trasparente e soprattutto inconsistente dal punto di vista epistemologico, a meno che, commentava sarcasticamente Morgan, egli non avesse voluto ammettere l'esistenza di entità "mistiche" capaci di dirigere il corso evolutivo:

If, however, you throw over the energy conception and substitute a mysterious and beneficent being that directs all things that are lawful and introduce a devil-of-a-fellow to mess things up generally and take a chance of coming out all right at the end, there might be some grounds perhaps for such a distinction, but from the energy point of view, as the physicist uses that term, this is a nonsense.⁵⁶

Molti passaggi erano poi carichi di retorica e privi di ogni rigore scientifico:

3. On page 95 you say: "The chemical or molecular and atomic constitution of the chromatin infinitely exceeds in complexity that of any other form of matter or energy known. As intimated above it not improbably contains undetected chemical elements". I understand, of course, that this is a sort of poetic outburst – not an accurate scientific statement, for as you will admit, of course, we know too little about the chemical composition of chromatin or about its method of action to warrant one in saying that it infinitely exceeds in complexity any other forms of matter and energy known.⁵⁷

Il vero punto debole di *The Origin and Evolution of Life* restava tuttavia il suo continuo rimandare a questioni inerenti alla fisica e alla chimica senza che queste venissero trattate in termini fisici o chimici. L'idea stessa che il mondo vivente, a differenza di quello inorganico, fosse dotato di

⁵⁴ *Ibidem*.

⁵⁵ G.E. Allen, *Thomas Hunt Morgan and the Emergence of a New American Biology*, "The Quarterly Review of Biology", 44, 2, 1969, p. 179.

⁵⁶ N. Reingold, *Jacques Loeb, the Scientist*, cit., p. 125.

⁵⁷ *Ibidem*.

una non meglio specificata forza ‘creativa’⁵⁸, nascondeva innumerevoli insidie concettuali. Proporre una distinzione ontologica fra organico e inorganico senza ricorrere ad analisi fisico-chimiche, lasciava spazio a qualunque tipo di interpretazione mistica:

[...] Here and elsewhere you intimate very strongly that there is some innate property (chemical, if you like) of living matter that makes it transcend all properties of other matter. Here, then we come to the “heart” of the subject. Even by intimating the possibility of such a conclusion you leave the safe fields of the energy conception and roam abroad in the Elysian fields of mystery.⁵⁹

Il ricorso al termine ‘energia’, spesso usato come sinonimo di ‘causa’ e ‘fattore evolutivo’, era vago e lontano dalle sue moderne concettualizzazioni: “[...] you did not live up to the high conception which you started, which I infer to be that of the modern school of biology”⁶⁰. Per Morgan non era sufficiente introdurre nuovi termini per raggiungere una migliore spiegazione scientifica. L’entelechia di Driesch, l’*élan vital* di Bergson e la stessa aristogenesi di Osborn altro non erano che manifestazioni dello stesso vizio speculativo: introdurre nuove parole allo scopo di nascondere la propria ignoranza delle cause dell’evoluzione, trasformando meccanismi sconosciuti in veri e propri misteri⁶¹.

5. Conclusioni

Morgan continuò a lamentare le fragilità degli scritti di Osborn per anni, talvolta in modo indiretto nei suoi saggi, altre volte per corrispondenza privata⁶². Alle accuse di vitalismo e misticismo, Osborn replicò di essersi

⁵⁸ “It is a continuous creation or creative evolution. Although this creative power is something new derived from the old, it presents the first of the numerous contrasts between the living and the lifeless world”: H.F. Osborn, *The Origin and Evolution of Life*, cit., p. 5.

⁵⁹ N. Reingold, *Jacques Loeb, the Scientist*, cit., p. 125.

⁶⁰ *Ibidem*.

⁶¹ T.H. Morgan, *A Critique*, cit., p. 59.

⁶² Un riferimento indiretto agli attacchi di Osborn si trova nelle pagine introduttive di *The Physical Basis of Heredity* (1919) dove Morgan, elencando le principali critiche alla teoria mendeliana, scrisse: “It has been argued that Mendelian phenomena relate to unnatural conditions and that they have nothing to do with the normal process of heredity in evolution that takes place in ‘nature’”, T.H. Morgan, *The Physical Basis*, cit., p. 18. In privato, Morgan continuò a criticare Osborn per il suo ostinato rifiuto del mutazionismo: “I am sorry to hear that the mammals have not evolved by mutation. It would be too bad to leave them out of the general scheme [...] and I cannot but hope that you will relent some day and let us have the mammals back”, N. Rainger, *An Agenda for Antiquity*, cit., p. 136.

sempre attenuto al ligio esercizio della scienza induttiva. Le sue ipotesi andavano distinte dalle speculazioni di Driesch, Bergson e Teilhard de Chardin poiché corroborate da un numero massiccio di prove fossili:

The origin and the evolution as revealed through paleontology go to prove that Aristotele was essentially right [...]. What this internal moving principle is remains to be discovered. We may first exclude the possibility that it acts either through supernatural or teleologic interposition through an externally creative power [...]. We may also exclude as unscientific the vitalistic theory of an entelechy or any other form of internal perfecting agency distinct from known and unknown physicochemical energies.⁶³

Nonostante queste precisazioni, l'opera di Osborn risultò per molti oscura e antiquata⁶⁴. Non solo gli sperimentalisti Morgan e Loeb, ma molti dei suoi più stretti colleghi al museo di New York avevano palesato dubbi sulla teoria dell'aristogenesi, al punto da costringerlo ad ammettere: "the new principles which I have enunciated from fifty-two years of paleontological research [...] have, so far as I know, gained no acceptance in the current realm of either biologic or paleontologic thought"⁶⁵.

L'insuccesso delle tesi di Osborn, un vero e proprio potentato della scienza americana⁶⁶, è esemplificativo rispetto agli standard epistemologici nelle scienze del vivente del tempo. Altrettanto significativamente, però, testimonia i limiti profondi della sua opera. Il tentativo di proporre una lettura multifattoriale del cambiamento evolutivo, di integrare nozioni provenienti da più campi scientifici e di trattarle attraverso un comune linguaggio teorico fondato sul concetto di 'energia' si scontrò contro il riduzionismo metodologico dello sperimentalismo, risentendo al tempo stesso di uno stile argomentativo obsoleto ed elusivo. In linea con la tradizione epistemologica di William Whewell e John Herschel, Osborn equiparava le cause dei fenomeni naturali a 'forze'⁶⁷. Nel caso dell'evoluzione, tali forze, o 'energie', operavano analogamente alla terza legge di Newton: agendo e retroagendo ai vari livelli della complessità organica⁶⁸. Come mostrano le critiche di Morgan, questa ulte-

⁶³ H.F. Osborn, *The Origin and Evolution of Life*, cit. p. 9.

⁶⁴ C.A. Clark, *God or Gorilla*, cit.

⁶⁵ H.F. Osborn, *Fifty-Two years of research*, cit., p. 73.

⁶⁶ S.J. Gould, *The Structure of Evolutionary Theory*, cit.; B. Regal, *Henry Fairfield Osborn*, cit.; Jedediah Purdy, *Environmentalism's Racist History*, "The New Yorker", 2015, 13 agosto.

⁶⁷ C. Johnson, *Darwin's Dice. The Idea of Chance in the Thought of Charles Darwin*, Oxford University Press, New York 2015, p. 50.

⁶⁸ H.F. Osborn, *The Origin and Evolution of Life*, cit. p. 13.

riore sovrapposizione fra il concetto di ‘causa’ e quello, non meglio specificato, di ‘energia’ pregiudicò la ricezione delle ipotesi del paleontologo.

Confrontandosi con la genetica, Osborn cercò di dimostrare che il concetto di mutazione era solo parzialmente compatibile con le prove fossili dell'evoluzione. La morfologia fossile corroborava l'idea di una distribuzione proporzionale dei caratteri confutando, però, la visione discontinuista e antiteologica dell'evoluzione di Bateson, De Vries e Morgan. In questo senso, è utile sottolineare che, nelle sue critiche al mutazionismo, Osborn non sembrò cogliere la profonda trasformazione concettuale introdotta da Morgan. Di fatto, egli utilizzò il termine ‘mutazione’ in modo indifferenziato⁶⁹, trascurando la distinzione fra macromutazione e micromutazione in termini di effetti fenotipici. Tanto le mutazioni descritte da De Vries che le mutazioni del moscerino della frutta implicavano per Osborn una forma di saltazionismo e, dunque, un'immagine della natura incompatibile con il gradualismo filetico.

Secondo la storiografia tradizionale, a sancire definitivamente la vanità degli sforzi di Osborn e della paleontologia ortogenetica sarebbe stato George Gaylord Simpson che, in *Tempo and Mode in Evolution*, definì la teoria dell'aristogenesi come implicitamente metafisica per il suo presupporre variazioni predeterminate⁷⁰. L'idea di una cesura netta fra paleontologia ortogenetica e sintetica presenta tuttavia una serie di criticità che meritano di essere analizzate. Certamente, Simpson mise a nudo l'ossessione per il linearismo e il progressionismo che aveva caratterizzato la vecchia generazione di paleontologi, per i quali la scoperta di sequenze lineari giustificava la teorizzazione di leggi e principi universali. Per Simpson, la macroevoluzione seguiva ritmi mutevoli e la selezione naturale restava la migliore teoria per spiegarne l'andamento. Nonostante questo, egli conosceva bene Osborn, nei confronti del quale dimostrò una considerazione che spesso è stata sottovalutata in letteratura. Del resto, Simpson aveva iniziato a collaborare con il dipartimento di paleontologia dei vertebrati del museo di New York proprio negli ultimi anni di presidenza Osborn, lavorando sul materiale che questi aveva catalogato e messo a disposizione.

⁶⁹ R. Rainger, *An Agenda for Antiquity*, cit., p. 138.

⁷⁰ Questa interpretazione dell'opera di Simpson è molto diffusa in letteratura. Si veda ad esempio E. Mayr, *The Growth of Biological Thought*, cit.; G. Pinna, *La natura paleontologica dell'evoluzione*, Einaudi, Torino 1995. Un'analisi critica della storiografia tradizionale è fornita da R. Delisle, *Les philosophies du Néo-Darwinisme*, PUF, Paris 2009, pp. 245-300. Per i commenti di Simpson su Osborn si rimanda direttamente a G.G. Simpson, *Tempo and Mode*, cit., p. 152.

Proprio in *Tempo and Mode*, Simpson riconobbe che, se si escludevano le sue speculazioni sulle cause dell'evoluzione, Osborn aveva contribuito a chiarire alcune “modalità” del cambiamento macroevolutivo, come, ad esempio, il parallelismo dovuto alla lontana condivisione di un antenato⁷¹. Soprattutto, però, i suoi scritti mostravano una propensione intellettuale al confronto rivelatasi lungimirante. Lo stesso anno in cui fu pubblicato *Tempo and Mode*, sul *Dictionary of American Biography* Simpson definì Osborn come uno degli scienziati più avveduti del suo tempo. Gran parte della sua carriera era andata sovrapponendosi agli anni di ascesa della genetica, il che lo aveva portato a scontrarsi con il riduzionismo metodologico dei primi sperimentalisti. Solo più tardi ci si sarebbe resi conto di quanto fosse desiderabile una “coordinazione fra paleontologia, biologia sperimentale e genetica”. Con energia e, talvolta, poca disciplina scientifica, Osborn aveva “tentato prematuramente una sintesi”⁷².

Lo sforzo teorico di Simpson, per il quale la specializzazione dei saperi biologici rappresentò una delle ragioni fondamentali della Sintesi Moderna⁷³, nasceva da una esigenza epistemologica comune a quella che aveva portato Osborn a integrare mendelismo e ortogenesi. L'opera di questo autore, in tutti i suoi limiti argomentativi e teorici, delineò una zona grigia fra la ‘vecchia morfologia’ e la ‘nuova genetica’⁷⁴. Al tempo stesso, una demarcazione storiografica troppo netta fra paleontologia ‘pre-sintetica’ e ‘post-sintetica’ ci sembra non cogliere le sfumature di questa transizione. L'idea di una profonda discontinuità teorica ed epistemologica, oltre a presupporre un'omogeneità interna alla Sintesi Moderna⁷⁵, perde di vista la complessità di una delle fasi più delicate della storia dell'evoluzionismo.

⁷¹ Ivi, p. 59; G.G. Simpson, *Principles of Animal Taxonomy*, Columbia University Press, New York 1961.

⁷² G.G. Simpson, *Osborn, Henry Fairfield*, in Harris Starr (ed.), *Dictionary of American biography*, XXI, Oxford University Press, Humphrey Milford, London 1944, p. 586.

⁷³ G.G. Simpson, *Tempo and Mode*, cit., p. XV.

⁷⁴ R. Rainger, *Vertebrate Paleontology as Biology*, cit.

⁷⁵ J. Cain, *Rethinking the Synthesis Period in Evolutionary Studies*, “The Journal of the History of Biology”, 42, 2009, pp. 621-648; R. Delisle, *Introduction: Darwinism or a Kaleidoscope of Research Programs and Ideas?*, in Richard Delisle (ed.), *The Darwinian Tradition in Context: Research Programs in Evolutionary Biology*, Springer, Cham 2017, pp. 1-8.

Focus

“The philosophy, ethics, and politics
of epidemiology today”

ed. by Stefano Canali and Corrado Piroddi

Introduction. Which philosophy, ethics, and politics for epidemiology today?

Stefano Canali^{*}, Corrado Piroddi^{**}

Keywords: Philosophy of Medicine; Philosophy of the Social Sciences; Epidemiology

Epidemiology is an area of research that has a relatively short history, if compared with other disciplines, and one that lives at the intersection of several of these other areas in biomedicine and beyond¹. In this sense, philosophical, political, and ethical considerations have a similarly recent and interdisciplinary history.

Starting from Alex Broadbent's seminal book², some philosophers have increasingly focused on epidemiological research and its methods, models, theories, data, etc. Philosophical interests in this area have come from the intersection with work on the philosophy of medicine and biomedical research, the life sciences and biology, public health and the socio-political status of disease and health. More recently, a special issue of the journal *Synthese*, dedicated to a re-introduction of the state of philosophy of epidemiology, has provided an overview of the topic and issues that have defined philosophy of epidemiology so far³. Following a traditional focus of philosophy of science, philosophers of epidemiology have for instance discussed the epistemic nature and status of theories in epidemiology, often on the basis of the analysis of classic texts of epidemiology. Relatedly, causal inference has been extensively discussed, as a consequence of the cen-

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¹ A. Morabia (ed.), *A History of Epidemiologic Methods and Concepts*, Birkhäuser Verlag, Basel 2005.

² A. Broadbent, *Philosophy of Epidemiology*, London, Palgrave Macmillan, London 2013.

³ J.M. Kaplan, S. Valles, *Reflecting on what philosophy of epidemiology is and does, as the field comes into its own: Introduction to the Special Issue on Philosophy of Epidemiology*, "Synthese", 2019.

trality of causality in both epidemiology and philosophy of science⁴. Partly in connection to questions about the evidential basis of causal inference, philosophers have analysed the types of measurements and data collection practices employed in epidemiology⁵, in connection with trends and movements in biomedical research (evidence-based medicine, personalised medicine, genomics) and the sciences more generally (big data, data-intensive approaches). The role of epistemic and non-epistemic values in epidemiological research has been analysed in the context of disputes and debates on epidemiological practice⁶. In line with approaches and lines of research in philosophy of science and beyond, the Eurocentrism of both epidemiology and philosophy of medicine and epidemiology has increasingly been criticised and debated in recent years⁷. And many of these topics have been developed in close collaborations between philosophers and epidemiologists, who have often contributed to debates in both fields⁸.

In the context of the COVID-19 pandemic, epidemiology has gained increasing – if not new – prominence for public, political, and academic discussions. Various discussions, critiques, and tensions have arisen in this context, involving epidemiological modelling, data, response measures, scientific communication, etc. Some philosophers have contributed to these discussions from the point of view of philosophy of epidemiology and beyond. Internally, this has led to discussions in academic philosophy about the role and contribution of the field in cases of emergency such as the pandemic. At a more external level, interactions between philosophers, epidemiologists, meta-scientists and other researchers have been established. More generally, however, we think that the COVID-19 pandemic can be a starting point for a more general reflection on the status of philosophical considerations on epidemiology and medicine. Crucially, we will argue that this needs to go in direction of a more integrative approach to the study of these disciplines and issues, which comprises philosophy of science as well as critical theory, political philosophy, philoso-

⁴ F. Russo, J. Williamson, *Interpreting Causality in the Health Sciences*, “International Studies in the Philosophy of Science”, 21, 2, 2007, pp. 157-170.

⁵ S. Leonelli, N. Tempini, *Where Health and Environment Meet: The Use of Invariant Parameters in Big Data Analysis*, “Synthese”, 2018.

⁶ S. Valles, *Philosophy of Population Health: Philosophy for a New Public Health Era*, Routledge Press, London 2018.

⁷ S. Valles, *A Pluralistic and Socially Responsible Philosophy of Epidemiology Field Should Actively Engage with Social Determinants of Health and Health Disparities*, “Synthese”, 2019.

⁸ J.P. Vandenbroucke, A. Broadbent, N. Pearce, *Causality and Causal Inference in Epidemiology: The Need for a Pluralistic Approach*, “International Journal of Epidemiology”, 45, 6, 2016, pp. 1776-1786.

phy of medicine, science and technology studies, etc. The pandemic has highlighted many issues that require additional and close attention after the immediate aftermath of the pandemic and are significant for epidemiological and philosophical analyses beyond the context of the current spread of COVID-19. This focus of “Mefisto” can be considered one of the first new steps in this direction, and in this introduction we specify what we mean by such an integrative approach, where we see this applied in the context of the articles of this issue and how we can move forward.

A crucial reason for the adoption of an integrated approach is the urgency to avoid any denial of the complexity of the current situation and the consequent polarization of ideas and positions. Lately, we can see how this risk is present in the sphere of public opinion and in the scientific community as well: suppressive measures vs mitigation strategies, prudence vs proportionality, predictive models vs randomized control trials. It is reasonable to think that such cleavages might replicate themselves in the philosophical community, which is already characterized by a high level of disagreement and parochialism. In this sense, this volume aims to instead promote ecumenism and intellectual cooperation between different philosophical perspectives that address the same set of topics using different methodological approaches and writing styles. But what are the possible reciprocal benefits and advantages that such a dialog can produce?

Thanks to normative ethics, biopolitics and critical theory, analytic approaches to the philosophy of medicine and epidemiology can gain more indications concerning the social and historical origins of the limits of epidemiological models and practices. Through their genealogical and historical methods, and normative perspective, ethics, biopolitics and critical theory can clarify questions like: Why are non-epistemic and epistemic values strongly imbricated in public health policies? Why do SIR and SEIR models tend to opt for an aggregate of individual-level observation as evidence base, instead of considering also socio-economic conditions? To what extent and how can scientific communication be manipulated according to a political agenda or ideology?

In turn, the analytic philosophy of medicine and epidemiology can help philosophers to understand in which cases, and to which extent, scientific concepts, discourses, and practices sideline the effects of non-epistemic values and factors. There is no doubt that the latter can influence epidemiological models, their presuppositions, their mathematical structure, and the collection and quality of data that drive their predictions. An analytic, rigorous, and argumentative approach can uncover logical inconsistencies and produce a conceptual analysis capable of explaining the

intersection and interaction between medical concepts, which are often supposed to be theoretically neutral, and economic, social, and political ideas and values.

Thus, this dialogue can promote an eclectic perspective that does not embrace a totalizing and pessimistic critique of scientific reason but does not depict medical science as a smooth, value-free domain either. In an analogous way, the confrontation between these two different philosophical branches can also help us to better understand how and when public health policies (or biopolitics and biopower, if you prefer) “exerts a positive influence on life that endeavors to administer, optimize, and multiply it, subjecting it to precise controls and comprehensive regulations”⁹. This could mean, for instance, preventing the collapse of the health care system, protecting individual and public health, while respecting principles of prudence and proportionality without enacting health restrictions through mere coercion and mystification.

In presenting this approach we thus hope to promote a new philosophical point of view, which goes beyond the false dichotomy between a medical science that is integrally objective and totally based on facts and a medical practice that is necessarily an expression of asymmetric relations of power and, to some extent, oppression. The contributions in this focus of “Mefisto” implement this approach by discussing and analysing the following cluster of topics.

Data and evidence are of course crucial components of any area of scientific research, but are perhaps particularly interesting in the context of biomedicine and epidemiology more specifically. The historical rise of epidemiology as an area of research is crucially linked to the collection of data on populations by national states as well as its role as a provider of evidence for public health interventions¹⁰. In recent years, an increase in the volume of data that can be collected, analysed stored, and used for research has affected epidemiology too and yielded epistemic strategies for the integration of diverse datasets into bodies of evidence and knowledge¹¹. At the same time, the topic of evidence is often a contested issue in biomedical research, especially in connection to movements such as Evidence-Based Medicine and specific ways to classify and evaluate qual-

⁹ M. Foucault, *The History of Sexuality, Vol. I*, Vintage Book, New York 1978, p. 137.

¹⁰ A. Morabia, *A History of Epidemiologic Methods and Concepts*, cit.

¹¹ S. Canali, *Making evidential claims in epidemiology: Three strategies for the study of the exposome*, “Studies in History and Philosophy of Biological & Biomedical Sciences”, 2020, 82, 101248.

ity¹². In this broader context, data and evidence have been at the centre of increasing attention during the COVID-19 pandemic, whereby some commentators have argued that the evidential basis of mitigation measures such as lockdowns has very low quality¹³. This has opened up an important debate on the quality of COVID-19 data and, more generally, the intricate relations between scientific evidence and policy-making¹⁴. Tapping into these issues, in their article Cristina Amoretti and Elisabetta Lalumera investigate the data practices connected to counting deaths by COVID-19. Amoretti and Lalumera show that these practices, and thus the data themselves, cannot be considered objective in a simplistic sense of the word, as they rather reflect and encapsulate value judgements made at various steps of the process. This is an important point in the context of the debate on COVID-19 evidence, where arguably outdated notions of objectivity and data as neutral entities are employed. Susanne Bauer additionally situates the epistemic, social, and political dimensions of data practices in the epidemiology of COVID-19 with a contribution that discusses instances of what she calls “capture-all enumerative infrastructures”, i.e. epidemiological devices, approaches, and technologies that have been used in the context of the pandemic to track its development and spreading and ground policy interventions. Analysing the bathtub/container model of population, semi-automated dashboards, omics techniques, and remote sensing technologies as examples of these infrastructures, Bauer argues that several of these efforts run the risk of increasing stratification, segmentation, and injustice.

A second theme that the articles of this issue engage with is the role of *models and modelling* in epidemiology. Scientific models have been a topic of significant interest in the philosophy of science literature of the last two to three decades as a result of their crucial role in scientific practices and epistemic dimensions that are different from scientific theories. In this context, philosophers have discussed the epistemic dimensions and features of models, their relation to data and theories, the ways in which models represent the world, explain, etc.¹⁵. As for biomedicine and epide-

¹² J. Worrall, *What Evidence in Evidence-Based Medicine?*, “Philosophy of Science”, 2002, 69, S3, S316-S330.

¹³ J.P. Ioannidis, S. Cripps, M.A. Tanner, *Forecasting for COVID-19 has failed*, “International Journal of Forecasting”, 2020.

¹⁴ J. Fuller, *Models v. Evidence*, “Boston Review”, 2020. Available at: <https://bostonreview.net/science-nature/jonathan-fuller-models-v-evidence>

¹⁵ D. Bailer-Jones, *Scientific Models in Philosophy of Science*, University of Pittsburgh Press, Pittsburgh 2009.

miology in particular, modelling is a more recent and yet increasingly central tool for studying disease and health in populations¹⁶. Such a centrality has, again, been particularly highlighted by the COVID-19 pandemic, where specific models (e.g. the Imperial College model) and specific types of modelling (e.g. compartment models) have taken central stage and have gained political and media exposure, increasing scientific discussions on the limits of models¹⁷ and philosophical analyses of their predictive abilities¹⁸. The articles we present in this issue focus on and extend this discussion on the limits and dimensions of epidemiological models. In their paper, Federica Russo and Myke Kelly critically assess the ways in which epidemiological models have approached public health. Their claim is that the assumptions employed in modelling have several limits and in particular focus almost solely on aggregates of individuals, thus mostly obscuring social dynamics and mechanisms. This limitation opens up the possibility for other and different approaches to modelling, which include a more clearly social component and population character, and in this sense their work gives substance to many discussions we have witnessed during the COVID-19 pandemic about the social character of health and public policy interventions. Cristina Amoretti and Elisabetta Lalumera's work in their article is also important in this context, as they highlight the various assumptions that affect and realise the evidential significance of COVID-19 death data. These include assumptions about which aspects and elements of public health have to be protected and how they need to be protected, including for instance prevention and treatment. Susanne Bauer's article is equally concerned with the epistemic and infrastructural role of models in epidemiology, and particularly with the ways in which a specific model – the bathtub/container model – frames the notion of population for epidemiological research. Bauer argues that the model is based on a mode of thinking according to which populations as entities need to be contained and this has key implications for which measures are conceptualized when it comes to public health.

The problem of what and how to include in conceptualisations of population, health, and disease, how to develop a more inclusive perspective on public health policies on this basis is a topic of key importance that is dis-

¹⁶ A. Morabia, *A History of Epidemiologic Methods and Concepts*, cit.

¹⁷ A. Saltelli *et al.*, *Five Ways to Ensure that Models Serve Society: A Manifesto*, "Nature", 582, 2020, pp. 482-484.

¹⁸ J. Fuller, *What Are the COVID-19 Models Modeling (Philosophically Speaking)?*, "History and Philosophy of the Life Sciences", 2021, 43, p. 47.

cussed in this volume, in particular in relation to the *democratic and political dimension of epidemiological research and public health measures*. In their article, Flavio D'Abramo, Giulia Gandolfi, Gerardo Ienna, Pietro Daniel Omodeo, and Charles Wolfe discuss the historical entanglements of medical expertise, economic interests and surveillance politics for analysing the political nature of today's public health policies and epidemiology. On one side, they sketch the general outlines of a political epistemology that is focused on analysing the political features embedded in a scientific praxis and method that are never totally pure or neutral. On the other side, they put the basis for developing a biopolitical viewpoint that is strongly materialistic, historically grounded, attentive to the conditions that can ensure the 'rational use of scientific rationality'. In doing so, they not only pose the basis for a biopolitical critique that is far from the doctrinal assumptions of the Italian theory and the messianic posture of Agamben's biopolitics, which tend to depict citizens as passive victims of a biopolitical Leviathan. They also support the idea that biopolitics as a method of inquiry can have a positive normative outcome, working in favor of non-alienated and emancipated forms of scientific knowledge and technology. In this sense, Susanne Bauer discusses some concrete cases of the biosurveillance systems that are often mentioned in the context of biopolitical discussions and concludes that several of these discussions can be brought to bear on the features of the infrastructures that are used to study and intervene on disease. Bauer proposes that a specific focus on "pandemic apparatus and viral infrastructuring" should be a crucial element of these discussions way of making these more concrete – with a move that we think goes in the direction suggested by D'Abramo, Gandolfi, Ienna, Omodeo, and Wolfe.

As such, the articles we present in the focus deepen the critical position of those scholars who underline the friction between *expertise and values* – i.e. the difficult relationship between the mathematical and scientific expertise, which epidemiological models embody, and the moral, social, and political values and variables that they claim to transcend. At the very least, epidemics do not happen in a vacuum. They explode in contexts that are often affected by profound and structural socio-economic inequalities. If already flu epidemics hit disproportionately individuals with low socioeconomic status¹⁹, it is reasonable to think that the same phenomenon can happen in the case of the spread of a different airborne virus like COVID-19. Poverty tends to overlap the conditions of margin-

¹⁹ C.M. Zipfel, V. Colizza, S. Bansal, *Health Inequities in Influenza Transmission and Surveillance*, "PLOS Computational Biology", 17, 3, 2021.

alization from which ethnic, cultural, religious groups might suffer. Thus, many of these same citizens are more susceptible to getting extremely sick or dying from flu or COVID-19 epidemics. The contributions of this focus of the journal discuss several of these elements, including conceptualisations of disease, health and populations (Federica Russo and Myke Kelly), values in counting practices (Cristina Amoretti and Elisabetta Lalumera), the intertwining of the epistemic, social and political dimensions of infrastructures (Susanne Bauer), the need for emancipated forms of science (D'Abramo and colleagues). At the same time, during the last year it has often been highlighted how non-pharmaceutical interventions, which are enacted following epidemiological forecasts, can exacerbate existing harms, or introduce new ones: employment loss, food insecurity for children previously receiving school lunch benefits, increased domestic violence, psychological suffering related to social distancing, weakening of democratic norms, procedures, institutions. However, little attention has been paid to the fact that, intersecting already existing social inequalities and asymmetries, epidemics generate and amplify generating *health disparities*. In this regard, SIR and SEIR models that are grounded on an aggregate of individual-level observation are problematic also because they do not or cannot identify how infections or deaths are socially distributed, or who is most vulnerable to fall sick or die. In other words, the expertise embodied in such models does not consider sufficiently that the most vulnerable individuals in the social dimension also have a moral claim to health capabilities that demands equal concern. Social interventions must mitigate their vulnerabilities and help recover their lives and livelihood. This means improving the socioeconomic conditions of the most vulnerable and making them capable of managing social interactions and engaging with the physical environment in such a way that prevents infections²⁰. Therefore, a more inclusive approach toward poorer subjects – such as the ones suggested by Myke Kelly, Federica Russo, and Susanne Bauer in their contributions – might help partially mitigating the health inequalities. It can influence the construction of epidemiological models and the design of health interventions that are more sensitive to the needs, material living conditions, and capabilities of underrepresented social groups and classes²¹.

²⁰ S. Venkatapuram, *Human Capabilities and Pandemics*, “Journal of Human Development and Capabilities”, 2020.

²¹ C. Timmermann, *Epistemic Ignorance, Poverty and the COVID-19 Pandemic*, “Asian Bioethics Review”, 2020.

The focus comes to a closing with two reviews that discuss books that focus on both ends of the spectrum when it comes to the epidemiology, sociology, and politics of epidemics and pandemics. *Pandemics: A Very Short Introduction* by C.W. McMillen is an introduction to the science, history, and sociology of pandemics. Closely to the contribution by D'Abramo, Gandolfi, Ienna, Omedeo and Wolf that we publish in this issue, McMillen shows the merits of looking at the history of pandemic management and the social nature of pandemics, which as we have discussed are far from purely biological entities. The extent to which we will learn from the history and management for COVID-19 for future scenarios and we will be shaped by the current pandemic as societies is something that we should reflect in the humanities and beyond. The second volume reviewed in our focus is a very recent contribution on the COVID-19 pandemic: *De la démocratie en Pandémie: Santé, recherche, éducation* by Barbara Stiegler. The book is a critical analysis of COVID-19 policy and identifies several pitfalls in the communication and management of the pandemic by European governments in general and the French context in particular. Moving forward in this critical work, we hope that the reviews and contributions we present in this focus will improve our understanding of COVID-19 and biomedical emergencies, but also push for a more grounded, productive and pluralistic role for philosophical reflections in the context of pandemics and beyond.

In closing, we would like to thank all the authors that have contributed to the publication of this focus, particularly the “Mefisto” editorial board for giving us the opportunity to build up this collection of essays and the anonymous reviewers for their excellent job and rigorous support. A special thank goes to a group of colleagues and friends who, while Europe was dramatically hit by the first wave of COVID-19, took part in the reading group “Epidemic, Emergency, and State of Exception”: Tuukka Brunila, Jarno Hietalahti, Antti Hämäläinen, Saana Jukola, Anna Kaisa Kärki, Arto Laitinen, Otto Snellman, Sini Tiihonen. The realization of this collection would not have been possible without their contributions, ideas, and intellectual efforts.

Non-epistemic factors in epidemiological models. The case of mortality data

M. Cristina Amoretti*, Elisabetta Lalumera**

Abstract: The COVID-19 pandemic has made it especially visible that mortality data are a key component of epidemiological models, being a single indicator that provides information about various health aspects, such as disease prevalence and effectiveness of interventions, and thus enabling predictions on many fronts. In this paper we illustrate the interrelation between facts and values in death statistics, by analyzing the rules for death certification issued by the World Health Organization. We show how the notion of the underlying cause of death can change in view of public health goals. This brings us to a general point about how non-epistemic factors, such as values and goals, are reflected in the choice of different measures in epidemiological models. We finally argue that this analysis is not only relevant from a theoretical point of view but also has important practical consequences.

Keywords: cause of death; COVID-19; epidemiological models; non-epistemic factors

1. Introduction

The current pandemic has made it especially visible that mortality data are a key component of epidemiological models, being a single indicator that provides information about various health aspects, such as disease prevalence and effectiveness of interventions, and thus enabling predictions on many fronts. In what follows, we will illustrate the interrelation between facts and values, that is, between epistemic and non-epistemic factors, in determining mortality data and then in realizing epidemiological models. More precisely, in section 2 we will analyze the rules for death

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certification issued by the World Health Organization with a specific focus on COVID-19 and we will show how the notion of the underlying cause of death can change in view of the public health goals of prevention and treatment, that is in view of non-epistemic factors. Then, in section 3, we will explain how mortality data might affect epidemiological models and we will evaluate how the choice of different measures in epidemiological models can also be affected by non-epistemic factors, such as social values and public goals. Finally, in section 4 we will argue that recognizing the presence of both epistemic and non-epistemic factors in epidemiological models does not undermine their objectivity or usefulness, and that our analysis is not only relevant from a theoretical point of view but also has important practical consequences.

2. *Facts and values in determining whether COVID-19 is the underlying cause of death*

The starting point of our analysis is assessing how a death due to COVID-19 is recorded and certified during the current pandemic. In order to do that, a brief analysis of the rules for the compilation of a death certificate that have been issued by the World Health Organization is necessary¹. These rules are in fact intended to provide instructions to reliably compile a death certificate, which is the form that contains all the relevant details about the deceased and, in particular, the specification of the so-called *underlying cause of death*, that is, “(a) the disease or injury that initiated the sequence of morbid events that led directly to death, or (b) the circumstances of the accident or violent act that produced the fatal injury”². This document must be completed by a doctor and a state official within 24 hours of the death, being then available for epidemiological and statistical research.

As we will see in the next section, it is pivotal not only that death certificates are filled in carefully, with the indication of the *real* cause of death, but also that they are drafted consistently and uniformly across all countries, so that the epidemiological and statistical models developed on their basis can be trustworthy and authentically useful. This becomes particularly relevant

¹ World Health Organization, *Medical certification of cause of death: Instructions for physicians on use of international form of medical certificate of cause of death*, World Health Organization, Geneva 1979; World Health Organization, *Coronavirus disease (COVID-19) Pandemic*, 2020, <https://www.who.int/emergencies/diseases/novel-coronavirus-2019> (accessed 6/12/2020).

² World Health Organization, *Medical certification of cause of death*, 1979, cit., p. 6.

in the case of a pandemic like that of COVID-19 as the mortality data obtained by looking at death certificates and the epidemiological models built on their basis inform media and institutional communication daily as well as the health policies and measures carried out by different governments.

Apart from small differences from country to country, the current format of a death certificate has been standardized by the WHO, which also establishes the exact codes of all the various diseases, as contained in the International Classification of Diseases, now in its eleventh edition (ICD-11). The WHO's death certificate has two main parts.

The first and most important part must be filled in with an indication of the *exact sequence of diseases or conditions that led to the death*, starting with the one that directly caused the death, that is, the so-called precipitating cause, then continuing in the line below with the disease or condition that caused the first one (expressed by the wording 'due to'), then again in the line below with the disease or condition that caused the second one, and so forth, up to the underlying cause of death. A very simple example could be the following causal sequence: 1) Acute respiratory distress syndrome (precipitating cause), 2) Pneumonia, 3) COVID-19 with positive test (underlying cause of death).

The second part of the death certificate must instead be filled out with the indication of all those conditions that are believed to have increased the risk or the severity of the underlying cause, but that are not part of the causal chain that directly led to death. As an example, if in the first part of the death certificate COVID-19 is indicated as the underlying cause of death, the second part can contain an indication of pre-existing chronic conditions (such as diabetes, coronary artery disease, circulatory diseases or cancers) or conditions that cause a reduction in lung capacity (such as asthma or COPD, that is, chronic obstructive pulmonary disease) capable of aggravating the clinical picture of COVID-19 and thus increasing the risk of death.

Filling in a death certificate is thus a very complex process, which includes diagnosis, certification and coding. Such a process can give rise to different types of errors, both systematic and accidental. Excluding manual and/or automatic coding errors, both the diagnosis and the identification of the underlying cause of death as well as a description of the exact sequence of diseases or conditions that eventually led to death not only depend on the experience of the physician but can also be influenced by various factors, such as the age and sex of the patient or the context of death³.

³ L. McGivern, L. Shulman, J.K. Carney, S. Shapiro, E. Bundock, *Death certification errors and the effect on mortality statistics*, "Public Health Rep", 132, 6, 2017, pp. 669-675.

One of the most relevant issues in compiling a death certificate concerns the uniqueness of the underlying cause of death. On the one hand, the WHO document explicitly states that identifying a single underlying cause of death is fundamental for epidemiological and statistical purposes; on the other hand, it is also recognized that it is increasingly frequent that death occurs in the presence of different diseases or conditions, thus posing a problem of selection. For this reason, the WHO also defines a set of rules to distinguish the underlying cause of death (along with the train of all other diseases or conditions that eventually led to death) from those other diseases or conditions that must simply be considered to have increased the risk or the severity of the underlying cause.

At first glance, it may seem that the underlying cause of death, which triggered the whole sequence of morbid events that led directly to death, must be identified simply looking at the pathogenetic mechanisms that emerged from biomedical research and are certified by scientific consensus, such as the mechanism that describes how the SARS-COV-2 virus binds to human cells and then replicates inside them. Indirect evidence that the WHO adopts a mechanistic view of causality can be represented by the so-called unacceptable or illogical causal sequences, which represent cases of pathogenetic mechanisms that do not exist from a medical point of view and thus cannot be included in a death certificate. For example, infectious diseases – such as COVID-19 – cannot be due to any other condition⁴; so, reporting COPD as the cause of COVID-19 would constitute an illogical causal sequence since COPD cannot cause an infectious disease such as COVID-19.

In the WHO document, however, we also read that “the expression ‘due to’ printed between the lines of the first part of the death certificate apply not only to sequences with a pathological or etiological basis, but also to sequences in which an antecedent condition is *held responsible* for having prepared the way for the most direct cause”⁵. This means that the choice of a specific causal chain is not wholly based on pure biomedical evidence.

The WHO document also recognizes that it is not easy for a doctor to decide when a certain disease or condition should be listed in the causal sequence that leads directly to death and nor among the diseases or con-

⁴ World Health Organization, *International statistical classification of diseases and related health problems, 11th revision (ICD-11), Reference Guide*, 2018, <https://icd.who.int/icd11ref-guide/en/index.html> (accessed 12/12/2020), sect. 2.21.

⁵ World Health Organization, *Medical certification of cause of death*, 1979, cit., p. 8, emphasis added.

ditions that simply increase the risk or the severity of the underlying cause. The suggestion – actually rather vague – is to include in the second part of the death certificate all those conditions that are relevant to death but that do not seem to be able to coherently fit into the causal sequence reported in the first part⁶. However, it is evident that the selection of the causal sequence that leads directly to death, and in particular of the underlying cause of death, is by no means a simple and linear process.

For example, generally speaking, COVID-19 can be considered the underlying cause of death (and thus included in the first part of a death certificate) when it has triggered all the other diseases or conditions, as recorded by the doctor, which directly culminated in the patient's death (such as pneumonia or acute respiratory distress syndrome). In this case, potential pre-existing chronic conditions (such as diabetes, coronary artery disease, circulatory diseases, cancers, asthma or COPD) capable of aggravating the clinical picture of COVID-19 and increasing the risk of death must be reported in the second part of the death certificate as they do not coherently fit into the causal sequence that actually led to death and is reported in the first part. On the other hand, COVID-19 can also occur simultaneously with other diseases or conditions that actually lead directly to death. In this case, COVID-19, not being part of the causal sequence that leads directly to death, should not be indicated in the first part of the death certificate, but (possibly) in the second part, among the conditions that increased the risk or severity of the underlying cause. This could be the case of an individual with COVID-19 who has a car accident or a myocardial infarction due to a pre-existing coronary artery disease (which is thus considered the underlying cause of death).

While the two alternatives above are rather clear from a theoretical point of view, they are much less so in practice. Given the sequence of causes listed in the first part of the death certificate, why must COVID-19 – and not, say, pneumonia or acute respiratory distress syndrome – be identified as the underlying cause of death, that is, as the *real* cause of death? Or, more relevantly, how is it possible to choose the underlying cause of death in a non-arbitrary way in the event that there are two or more plausible causal sequences that result in death? To put it differently, how to decide that COVID-19 is the underlying cause of death and coronary artery disease is just an aggravating factor or, vice versa, that coronary artery disease is the underlying cause of death and COVID-19 just an aggravating factor?

⁶ Ivi, p. 9.

According to the WHO, the selection of the underlying cause of death must be carried out with a view to preventing premature deaths and thus to hindering the precipitating cause from acting, which are the most effective goals for public health⁷. In other words, the choice of the underlying cause of death must be made not only on the basis of biomedical evidence, but also with the primary objectives of *prevention and treatment* in mind: the underlying cause of death must thus be identified with the disease or condition that can be better manipulated in order to realize the most effective goals for public health⁸. As we have already argued⁹, the WHO adopts a mechanistic view of causality but with an interventionist criterion to select the *real* cause of death: among the various plausible causal sequences (that is, the various plausible pathogenetic mechanisms) that led to death, the underlying cause of death must be identified with the disease or conditions that can be acted upon, plausibly at the population level, with prevention and treatment in mind. For example, let us assume that COVID-19 (A) and coronary artery disease (B) both led to death, but preventing A is easier than B, then A must be identified as the underlying cause of death, or if both conditions are equally possible to prevent but blocking A is more effective in avoiding premature deaths, then A must be identified as the underlying cause of death. Non-epistemic factors thus play a key role in the selection of COVID-19 as the *real* cause of that.

In the case of COVID-19, moreover, the situation is further complicated by the fact that a death caused by COVID-19 could be correctly recorded on a death certificate even in cases where the infection is only suspected or probable. The WHO in fact defines death caused by COVID-19 in the following way: “A death due to COVID-19 is defined for surveillance purposes as a death resulting from a clinically compatible [symptomatic] disease, in a *probable* or confirmed case of COVID-19 infection, unless a clearly alternative cause of death exists, which cannot be related to COVID-19 (for example, trauma). There should not be a period of complete recovery from COVID-19 between illness and death. A death due to COVID-19 may not be attributed to another disease (e.g., cancer) and should be considered as such regardless of pre-existing con-

⁷ Ivi, p. 5.

⁸ B.I.B. Lindahl, *On the selection of causes of death: An analysis of WHO's rules for selection of the underlying cause of death*, in L. Nordenfelt, B.I.B. Lindahl (eds.), *Health, disease, and causal explanations in medicine*, Springer, Dordrecht 1984, pp. 137-152.

⁹ M.C. Amoretti, E. Lalumera, *COVID-19 as the underlying cause of death: disentangling facts and values*, “History and Philosophy of Life Sciences”, 43, 1, 2020, 4, pp. 1-4.

ditions that are suspected to have triggered a severe course of COVID-19”¹⁰. Therefore, COVID-19 can be correctly considered the underlying cause of death even in the case of a mere suspicion, that is in the absence of a swab or serological test or other diagnostic imaging procedure that reliably confirms the infection.

To sum up, the WHO intends to consider COVID-19 as the underlying cause of death in all those cases in which it has actually caused, or is supposed to have caused, or contributed to causing the death of the patient¹¹. Such a recommendation may seem rather surprising, but it is in line with other indications in the ICD-11, which explain that the acceptability or otherwise of a causal sequence for the coding of mortality depends not only on biomedical assessments, but also on public health considerations. For this reason, a medically acceptable causal relationship could instead be judged unacceptable in the coding instructions as a later element in the causal chain is deemed more important from a public health perspective¹². Therefore, in our case, overwhelming public health reasons make it possible to indicate COVID-19 as the underlying cause of death even in the case of a mere unconfirmed suspicion, and thus to identify COVID-19 as the underlying cause of death even in the presence of other and independent causal chains that led to death. Such a rule conforms with the idea that the underlying cause of death must be selected with the primary objectives of prevention and treatment in mind.

3. Facts and values in epidemiological models: choosing between different parameters

As we have seen in the previous section, correctly reporting a COVID-19 infection on a death certificate is essential to understand how many individuals have actually died from COVID-19. Choosing between multiple alternatives and independent causal sequences (or between converging pathogenetic mechanisms) that result in death, however, is not always simple and immediate, and involves not only facts but also values taking into account the objectives of prevention and treatment.

¹⁰ World Health Organization, *Coronavirus disease (COVID-19) Pandemic*, 2020, cit., p. 3, emphasis added.

¹¹ *Ibidem*.

¹² World Health Organization, *International statistical classification of diseases and related health problems, Reference Guide*, 2018, cit., sect. 2.19.2.

The philosophical question of what counts as a death due to COVID-19 is philosophically interesting for its own sake, as it involves a reflection on conceptions of causality, and on the problem of the selection among potential concurrent causes. However, it is also and prominently relevant to understand, and ultimately to assess, epidemiological models of the current pandemic.

Generally speaking, epidemiological models are mathematical tools built to explain complex medical phenomena, such as the COVID-19 pandemic. Most of them have the structure of so-called SEIR models, that is, they represent individuals in a population as moving through four states – Susceptible to the disease, Exposed, Infected, and Removed (deceased or recovered) – as affected by various factors¹³. They can have the goal of predicting infection rates or death rates for a time and population, and/or to test the effect of mitigation strategies or other policies enforced by governments, as well as the effect of other factors such as schools reopening or seasonal change in infections and deaths. They are currently what national and local institutions mostly base their strategies on. Prominent models from the beginning of the pandemic were the Imperial College Model, the Institute for Health Metrics and Evaluation (IHME) Model, the London School of Hygiene & Tropical Medicine (LSHTM), and the Youyang Gu (YYG) model.

As the number of Infected is always unknown (as not everyone is tested), most of these models ‘fit’ confirmed deaths and calculate back how many infections would have been likely to produce such a result¹⁴. As we illustrated in the previous section, confirmed deaths due to COVID-19 are formally registered by national health authorities in a standardized way, so they make for ‘good’ data in this context. Models of the pandemic also build on data about the virus (the notorious R , the basic reproductive number, that is the average number of cases generated by a single infected individual), and about the population, such as age, mobility, health status, and family structure.

Data of all these sorts can come in either good or bad quality, and they can be scarce or sufficient, they can be either freshly collected, or rather retrieved from registries and repositories filled out in the past, with no control by the re-

¹³ M.J. Keeling, K.T. Eames, *Networks and epidemic models*, “Journal of the Royal Society Interface”, 2, 4, 2005, pp. 295-307.

¹⁴ C. Giattino, *How epidemiological models of COVID-19 help us estimate the true number of infections*. *Our World in Data*, 2020, <https://ourworldindata.org/covid-models>, (accessed 12/01/2021).

searchers now working on the model. Whatever the merits of these criticisms, the general point they presuppose is that for their epistemic credentials – in order to qualify as providing explanations and predictions of the phenomenon – models depend on the quality of data they are fed with. This is a point we will not pursue further, as it has been widely discussed in the recent literature¹⁵.

In the first part of this paper, we discussed a definition, that of death due to COVID-19, and showed that in itself it is value-laden. This means that epidemiological models that use data about the number of deaths due to COVID-19 are assuming data that are not ‘pure’ but constitutively dependent on non-epistemic values, such as the importance of prevention and treatment. However, models also depend crucially on parameters and definitions of parameters. These are not data, but conceptual tools that epidemiologists pick and choose – albeit with a limited degree of freedom – in order to manage data, with a view to the explanation and prediction of a phenomenon. Let us now broaden the view, and consider different parameters related to death, from which epidemiologists can, and do, pick and choose in model-building.

The first is infection fatality ratio (IFR), which estimates this proportion of deaths among all infected individuals. The second death-related parameter is case fatality ratio (CFR), which estimates this proportion of deaths among identified confirmed cases. They are both measures of the severity of the disease. Moreover, both IFR and CFR have the definition of death due to COVID-19 as an ingredient, and thus inherit, so to say, the value component we highlighted in the previous section. However, they are also significantly different.

IFR is the most speculative parameter, so to say, as it heavily depends both on testing, and on prior biological knowledge of the mechanisms of virus transmission. CFR is less speculative, but it is nevertheless exposed to specific biases (systematic errors). On a WHO fact sheet published in August 2020, we read that if deaths are more likely to be reported than recoveries, CFR will be overestimated, and the reverse leads to underestimation¹⁶. Biases apart, it is known that risk of death from COVID-19 is unevenly distributed among groups stratified by age, socio-economic status and ethnicity¹⁷. Choosing an undifferentiated CFR parameter is likely

¹⁵ For a review see, e.g., G.T.H. Ellison, *COVID-19 and the epistemology of epidemiological models at the dawn of AI*, “Annals of Human Biology”, 47, 2020, pp. 506-513.

¹⁶ World Health Organization, *Estimating mortality from Covid-19*, 2020, <https://www.who.int/news-room/commentaries/detail/estimating-mortality-from-covid-19> (accessed 22/01/2020).

¹⁷ G. Onder, G. Rezza, S. Brusaferro, *Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy*, “JAMA”, 323, 2020, pp. 1775-1776; S. Sze, D. Pan, C.R. Nevill,

to mask such differences in the predictions of a model, whereas choosing stratified CFR measures is likely to make them apparent. Such a choice involves social and ethical considerations, as models are intended to guide institutional interventions.

Another death-related parameter is the number of overall excessive deaths in a population – for example, the number of overall excessive deaths in Lombardy, Northern Italy, in March 2020, compared to the same region in November 2020 or March 2019. The choice of a measure of overall excessive deaths, versus deaths due to COVID-19 only, can show how the virus impacts on the overall health of the population, for example by limiting the quality and access of treatments for other pathologies, such as cancers, cardiovascular diseases, and so on. Therefore, the choice of this measure also implicitly assumes that actions aimed at preventing such an impact are worth taking.

Finally, using death parameters implies focusing on the goal of preserving life in general, and treating all deaths equally. Preserving life in general and treating all deaths equally is obviously good from an ethical point of view, but it can be qualified further when it comes to choosing the goals of healthcare strategies. A possible alternative to death parameters is counting Potential Years of Life Lost (PYLL). PYLL is a measure of the time a person would have lived had he or she not died prematurely. Choosing PYLL as a parameter means that not all deaths are treated equally, as greater weight is given to deaths at a younger age and a lower weight to deaths at an older age¹⁸.

We can easily see how death-related values and life-years lost values come apart when, as in the case of COVID-19, mortality is unevenly distributed on ages, and disproportionally affects the elderly. Differently, the Spanish flu killed people with average age of 28 and its burden in terms of number of life-years lost has been calculated as about 1,000-times higher than COVID-19 as of June 2020.

Governments' mitigation strategies and interventions can be affected by the choice of death-related or years-lost related parameters in a predictive model. It is plausible that, in some contexts, closing schools may

L.J. Gray, C.A. Martin, J. Nazareth, J.S. Minhas *et al.*, *Ethnicity and Clinical Outcomes in Covid-19: A Systematic Review and Meta-Analysis*, "EClinicalMedicine", 29-30, 2020, 100630, pp. 1-17.

¹⁸ A.K. Mitra, M. Payton, N. Kabir, A. Whitehead, K.N. Ragland, A. Brown, *Potential years of life lost due to COVID-19 in the United States, Italy, and Germany: An old formula with newer ideas*, "International Journal of Environmental Research and Public Health", 17, 12, 2020, 4392, pp. 1-9.

have an immediate decreasing effect on death-related values, but also an increasing effect on life-years lost in the long term, as life expectancy is known to decrease with school-years lost¹⁹. A model with only one of the two parameters would have the effect of orienting political decisions in favor or against school closing, while a model incorporating both could give a wider picture. Admittedly, effects of interventions on PYYL are more difficult to quantify and predict, as they locate in the distant future. However, not to consider such parameters at all in modeling a phenomenon is in itself a choice, and one that cannot be made on purely factual grounds²⁰.

4. Conclusions

To sum up, the aim of this paper was to unpack the various roles that non-epistemic factors might have in the making of epidemiological models of COVID-19, first by a zoom-in on the definition of death due to COVID-19 (section 2), then with a bird's-eye view on different parameters that can be incorporated into predictive epidemiological models (section 3). Specifically, the definition of a death due to COVID-19 rests on a choice, the choice of positively evaluating the goal of fostering public health through disease prevention and treatment, over the goal of preserving the epistemic and biomedical soundness of a causal inference about the underlying cause of death. In its turn, this definition figures as a component of death-related parameters, such as IFR and CFR. Death-related parameters, however, collectively represent only one option, as other measures may optionally be considered when modeling, such as life-years lost. Choosing between different parameters in epidemiological modeling does not depend on facts only, but also on goals and value assumptions, that is on non-epistemic factors.

Arguing that non-epistemic factors play a key role not only in determining what counts as a death due to COVID-19 but also in realizing the epidemiological models of the current pandemic, we do not mean to claim that such mortality data and epidemiological models are flawed, un-

¹⁹ D.A. Christakis, W. Van Cleve, F.J. Zimmerman, *Estimation of US children's educational attainment and years of life lost associated with primary school closures during the coronavirus disease 2019 pandemic*, "JAMA Network Open", 3, 11, 2020, e2028786.

²⁰ J. Fuller, *Why coronavirus death rates can't be summed up in one simple number*, "The Conversation", April 10, 2020, <https://theconversation.com/why-coronavirus-death-rates-cant-be-summed-up-in-one-simple-number-135758> (accessed 22/01/2021).

reliable, useless or non-purely scientific. That non-epistemic factors play an important and unavoidable role in the scientific enterprise – not only in medicine but also in the so-called ‘hard’ sciences – is a widely recognized and well-documented issue, defended on historical, sociological, and philosophical grounds²¹. More importantly, it has convincingly been argued that the presence of non-epistemic factors within the various sciences does not undermine their epistemic reliability and objectivity but can possibly strengthen it²². For instance, Helen Longino²³ argues that scientific objectivity lies in the fact that scientific statements and models can be inter-subjectively tested and criticized, thus being a social product. Alternatively, Sandra Harding²⁴ claims that certain standpoints – those of marginalized and underprivileged social groups – are epistemically privileged or advantaged and thus the presence of their associated values in the scientific enterprise can be beneficial.

The fact that the mortality data of COVID-19 and the epidemiological models attempting to describe the current pandemic depend on both epistemic and non-epistemic factors is not only relevant from a theoretical point of view but also has many important practical consequences. Specifically, it makes it clear that such data and models should be explained and discussed publicly. On the one hand, the interplay of facts and values must be made explicit to the general public and the two components must be carefully separated and evaluated independently. On the other hand, and more importantly, it must be clarified that whereas facts can only be acknowledged, values and goal-related choices may and should be rationally discussed on practical and ethical grounds (this is why knowing where they are located, in the complex machinery of models, can be extremely useful). For example, are prevention and treatment good things to be pursued? Should all deaths be considered equally? What conflicting values are possibly at stake? Such a discussion must be open and public,

²¹ H. Douglas, *Inductive risk and values in science*, “Philosophy of Science”, 67, 2000, pp. 559-579; H. Kincaid, J. Dupré, A. Wylie, *Value-free science? Ideals and illusions*, Oxford University Press, Oxford, 2007; T. Kuhn, *The structure of scientific revolutions*, The University of Chicago Press, Chicago IL 1962.

²² E. Anderson, *Uses of value judgements in science: A general argument, with lessons from a case study of feminist research on divorce*, “Hypatia”, 19, 2004, pp. 1-24; J.A. Kourany, *Philosophy of science after feminism*, Oxford University Press, Oxford 2010; S. Harding, *Whose science? Whose knowledge? Thinking from women's lives*, Cornell University Press, Ithaca 1991; Id., “Strong objectivity”: A response to the new objectivity question, “Synthese”, 104, 1995, pp. 331-349.

²³ H.E. Longino, *Science as social knowledge: Values and objectivity in scientific inquiry*, Princeton University Press, Princeton 1990.

²⁴ S. Harding, *Whose science?*, cit.

and not concealed in some secret cabinet, as the consequences of a choice of alternative values and goals will have a great impact on everybody's lives. In this paper we do not aim at assessing potential different choices along with their consequences, but simply at suggesting the importance of making these choices explicit in order to improve the collective understanding of the current pandemic and to clarify the rationale of specific health policies and measures, as well as political decisions.

Pandemic infrastructure: epidemiology as compartmentalization

Susanne Bauer^{*}

Abstract: This article examines modes of containment and compartmentalization in epidemiology and pandemic response. Modern epidemiology is positioned as the key method in public health science and source of information for pandemic response policies. The epidemiological apparatus of observation works with tracking and sense-making techniques at the intersection of demography and biometrics. With late 20th century technoscientific developments, epidemiology has acquired a particular form of outcomes research. This includes a particular infrastructural enactment of the concept of ‘population’, prompting specific modes of data capture and containment that also feature in today’s coronavirus dashboards. Building on genomics data repositories, epidemiological study designs mediate data recombination that repurposes existing databases and promotes capture-all techniques for viral surveillance. Focusing on the orderings enacted by the epidemiological techniques in their formation, legacies, and actualizations, I discuss how data-intensive biosurveillance and efforts to foster openness are currently transforming the ‘epidemiologic gaze’. As ‘capture-all’ technologies operate across heterogeneous worlds, they fail to capture the implications of inequitably distributed risks and benefits in global health. Analyzing the apparatus of observation and capture in epidemiology can make room for engaging differently with numerous devices toward more equitable public health responses.

Keywords: epidemiology; infrastructure; calculative techniques; data practices; COVID-19

1. Introduction

Just a few years back, the topic of ‘epidemiology today’ would hardly have been concerned with a virus, and may have instead focused on non-transmissible chronic diseases. Academic epidemiology has been empha-

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sizing the acclaimed 20th century ‘epidemiological transition’ away from infectious disease and shifting the concerns of public health science toward chronic disease¹. This position, situated in western biomedicine and in the global north, implicitly assumed that the problems of infectious disease were to be solved through ‘economic development’. Moreover, during the second half of the 20th century, the science of epidemiology had transformed into a managerial toolbox of ‘outcomes research’², generalizing its field as the study of “distributions and determinants of health and disease in populations”³. Practiced as the study of patterns and determinants of health and disease in population groups, public health emerged as a biopolitical domain of population governance and individualized risk factor optimization⁴. However, controversies within epidemiology have questioned whether the future of the discipline would be in its development as a molecular science or as a social science, also challenging the one-approach-fit-all framework of risk factor epidemiology⁵. More recently, debates have focused on how digital epidemiology and new modes of intense data sourcing have begun to challenge established study designs⁶. Deliberations on epidemiology’s futures and methodologies have been tied to techno-scientific infrastructures which have many layers of history and politics. Social studies of medicine and public health have exposed racialized disparities and carved out a long history of struggle for more equitable public health⁷. Racialized epistemic infrastructures of western sciences are still shaping today’s technologies of automation, image recognition, machine learning and artificial intelligence techniques⁸.

¹ M. Susser, *Epidemiology Today: ‘a Thought-Tormented World’*, “International Journal of Epidemiology”, 18, 3, 1989, pp. 481-488.

² M. Jefford, M.R. Stockler, M.H. Tattersall, *Outcomes Research: What Is It and Why Does It Matter?*, “International Medical Journal”, 2003, 33, 3, pp. 110-118.

³ J. Last, *A Dictionary of Epidemiology*, Oxford University Press, New York 2001.

⁴ D. Lupton, *The Imperative of Health and the Regulated Body*, Sage, London 1995.

⁵ During the 1990s in the early genomics era, hopes for breakthroughs in genetic epidemiology through the study of genetic polymorphisms and susceptibility genes were centerstage. See M.J. Khoury, *Human Genome Epidemiology: Translating Advances in Human Genetics Into Population-Based Data for Medicine and Public Health*, “Genetics in Medicine”, 1, 3, 1999, pp. 71-73.

⁶ See for instance: A.E. Aiello, A. Renson, P.N. Zivich, *Social Media- and Internet-Based Disease Surveillance for Public Health*, “Annual review of public health”, 41, 2020, pp. 101-118; M. Höhle, *A statistician’s perspective on digital epidemiology*, “Life Sciences, Society and Policy”, 13, 1, 2017, p. 17.

⁷ A. Nelson, *Body and Soul: The Black Panther Party and the Fight Against Medical Discrimination*, University of Minnesota Press, Minneapolis 2013.

⁸ R. Amaro, *Machine diagnosis*, Onlineopen.org, 28 April 2020, <https://onlineopen.org/machine-diagnosis>

Technoscience has often been positioned as the way out of contemporary crisis, such as the energy crisis, climate change, or the current COVID-19 pandemic. Recently, many political programs have related to science as something solidified and fixed – where people either follow or deny science. Climate movements campaign for science and the model predictions for global warming, advocate with slogans such as “unite behind the science” or “the science is clear”⁹. Recognition and awareness of the urgency of climate change has been a significant struggle for scientists and climate movements alike, as action has been slow. Compared to the immediate urgency of the global pandemic due to a respiratory virus, climate issues have been conceived as a longer term concern. Across research areas, modelling has evolved into the dominant way of scientific sense making. This article focuses on some of the calculative infrastructures and epistemic legacies that continue to shape responses to the current pandemic.

Regarding government responses to the COVID-19 crisis, the World Health Organization (WHO), together with other international agencies, recently issued a statement on how the pandemic has also been an “infodemic”¹⁰. Examining the countless and often skewed mapping attempts of regional pandemic situations in the US, human geographer Taylor Shelton pointed to a shift towards a ‘post-truth’ disposition in contemporary social life” and an unparalleled “post-truth pandemic”¹¹. Concerned about some trends in deconstructionist science studies, climate change denial and creationism in the US as symptoms of a larger crisis of expertise, Bruno Latour once noted that critique (of science) “had run out of steam”¹². While climate science and action has involved decades of slow processes in scientific committees such as the Intergovernmental Panel on Climate Change (IPCC), the COVID-19 pandemic brought science in the making into the public arena in unprecedented ways.

Data collection, developing metrics, and modelling are important for scientific predictions and policy responses. In a paper on epidemiologi-

⁹ See for instance Fridays for Future, <https://fridaysforfuture.org/>

¹⁰ WHO, *Managing the COVID-19 infodemic: Promoting healthy behaviours and mitigating the harm from misinformation and disinformation*. Joint statement by WHO, UN, UNICEF, UNDP, UNESCO, UNAIDS, ITU, UN Global Pulse, and IFRC, Geneva 2020, <https://www-who-int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation#:~:text=An%20infodemic%20is%20an%20overabundance,of%20groups%20or%20individuals>

¹¹ T. Shelton, *A Post-Truth Pandemic*, “Big Data & Society”, July 2020. doi:10.1177/2053951720965612.

¹² B. Latour, *Why Has Critique Run Out Of Steam? From Matters of Fact to Matters of Concern*, “Critical Inquiry”, 30, 2004, pp. 225-248.

cal models of COVID-19, Warwick Anderson examined how modelling became the dominant mode of knowledge in pandemic response and called for a more heterogeneous and critical account of modelling¹³. At the same time, modelling practices also worked to expose to the broader public the heterogeneous processes of science in the making: how model predictions can change on a daily basis with new data, adjustments in modes of counting or virus mutations, and methods development. The evolving, unpredictable situation with exposures and protective measures hitting unequally, seemed to additionally fuel the crisis of expertise. Uncertain and dynamic, once the models became temporarily solidified and entered the policy-making processes, measures like restricting contacts or closing schools resulted in unprecedented repercussions to everyday life.

This paper centres on compartmentalization and ordering of data, their historical formation, and performative re-articulation. I attend to how emergent online dashboards and their publics as well as quests for openness and transparency are transforming the ‘epidemiologic gaze’. What kind of collective sense-making takes place with calculative infrastructures, as they are put to work, maintained, consulted, and used for infection tracking and policy-making?¹⁴ How do measurement infrastructures and semi-automated reporting encounter and “techno-digest”¹⁵ the virus during a pandemic? Or, vice versa, how does the virus traverse through nature-culture networks, mutate, and modify socio-technical arrangements? Beginning with technoscientific apparatus and epidemiological population thinking, this paper discusses the workings of emergent global tracking devices. Hence, it sets out to examine emergent ‘capture-all’ approaches in monitoring and data stockpiling on the one hand and

¹³ See W. Anderson, *The Model Crisis, or How to Have Critical Promiscuity in the Time of COVID-19*, “Social Studies of Science”, 51, 2, 2021, pp. 167-188. For modelling and publics, see C. Montgomery, L. Engelmann, *Epidemiological Publics? On the Domestication of Modelling in the era of COVID-19*, “Somatosphere. Science, Medicine and Anthropology”, 10 April 2020.

¹⁴ While numerous apps for tracking of proximity to an infected person or contact tracing have been developed, this paper focuses on epidemiological infrastructures of counting cases, measuring incidence and comparing rates. For analyses of apps, see for instance L.C. Graham, *Making Sense of Algorithms: Relational Perception of Contact Tracing and Risk Assessment during COVID-19*, “Big Data & Society”, January 2021. doi:10.1177/2053951721995218.

¹⁵ For the concept of ‘techno-digestion’, see D. Haraway, *A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s*, “Australian Feminist Studies”, 2, 4, 1987, pp. 1-42. For an account of epidemiological practice, building on the concept of techno-digestion, see S. Bauer, *Indexing, Coding, Scoring: The Engine Room of Epidemiology and its Routinized Techno-Digestions*, “Somatechnics”, 9, 2-3, 2019, pp. 223-243.

the trajectory of the virus through socio-epidemiological assemblages on the other hand.

2. *Technoscience and its apparatus of observation*

In the midst of a global pandemic and a rise of post-truth attitudes in politics, studying the making of epidemiological numbers in terms of a stabilization process can look troubling. This paper proposes to examine those troubles by building on two strands of technoscience studies: studies of technoscientific apparatus and critical studies of infrastructures. While technoscience is needed to respond to the virus, this should not prevent the modes of engagements with technoscience from working against the violence imbued in technomodernity and towards more equitable relations, human and more-than-human. In other words, we need to work, as feminist technoscience studies scholar Michelle Murphy put it in studying chemical infrastructure, “*with and against technoscience*”¹⁶. This includes staying attentive to new societal segmentations introduced through technoscientific ‘solutions’, while working to transform the epistemic infrastructures into workable means toward social and environmental justice.

In order to study the technoscientific apparatus, it is helpful to look into the theorization of phenomena by feminist science studies scholar Karen Barad¹⁷. Going beyond the analysis of models in terms of representation, Barad’s *Meeting the Universe Halfway* opens up for a more symmetric account of the apparatus of observation and the phenomena under study. In this conceptualization, measurement devices and recorded phenomena “intra-act,” as phenomena are both produced and have agency; they remain in tension, their very materialities resist and leave traces in the apparatus of observation, which generates data within the apparatus’ inscription devices. Such an approach opens up for diffracting epidemiological practices of registering, abstracting, and modelling, while acknowledging the agency of the emergent phenomena beyond their constructedness. Imbued with agency within the measurement set-up, the phenomena stabilized in those settings

¹⁶ M. Murphy, *Alterlife and Decolonial Chemical Relations*, “Current Anthropology”, 32, 4, 2017, pp. 494-503.

¹⁷ K. Barad, *Meeting the Universe Halfway. Quantum Physics and the Entanglement of Matter and Meaning*, Duke University Press, Durham 2007.

are already conditioned by infrastructural legacies and traditions of scientific observation. Epidemiological devices – study designs, transmission models from previous epidemics, and statistical decision criteria – can be understood as sites where multiple ‘intra-actions’ take place.

For a closer analysis of ‘intra-actions’ within epidemiological data work, one also needs to attend to the procedures of quantification and the workings of epidemiological enumeration, from measurement to policy effects. As empirical philosopher Helen Verran notes, “thinking about numbers takes them as inseparable from the practices in which enumerated material entities come to life, and as semiotically agential. [...] It recognises that the workings of numbers are deeply embedded in and constitutive of the real – they lubricate its happening”¹⁸. Adopting such a symmetric move in grasping the workings of numbers in epidemiological surveillance and pandemic response, this contribution combines insights from the conceptualization of ‘intra-action’ and examinations of numbers as agential and relational.

Taking up approaches of infrastructure studies to address public health practices redirects the focus on data collecting, scoring and decision support systems. These have proliferated in the healthcare sector as techniques for optimization of health-related outcomes, including economic efficiency. However, monitoring works with both epistemic and mundane infrastructures. Several decades after the “epidemic of signification” described by cultural studies scholar Paula Treichler in her account of the HIV/AIDS epidemic¹⁹, we are witnessing another iteration in an ongoing “epidemic of indexing”²⁰. These are linked to accelerated modes of data recombination and the troubled legacies of racialized knowledge production which are still present in demography and biometrics and become reactivated in new techniques of indexing. There are ongoing processes of “retrofitting”²¹ in epidemiology’s knowledge infrastructures, including classifications and analytic methods. Epidemiological infrastructure work also involves mundane data work, development of data collection standards building on existing classifications, and programmed interfaces for enumeration to be maintained and cared for. In

¹⁸ H. Verran, *Number*, in N. Wakeford, C. Lury (eds.), *Inventive Methods: The Happening of the Social*, Routledge, Abingdon 2010, pp. 110-124, 112.

¹⁹ P.A. Treichler, *AIDS, Homophobia and Biomedical Discourse: An Epidemic of Signification*, “Cultural Studies”, 1, 3, 1987, pp. 263-305.

²⁰ S. Bauer, *Indexing, Coding, Scoring*, cit.

²¹ C. Howe, J. Lockrem, H. Appel et al., *Paradoxical Infrastructures: Ruins, Retrofit, and Risk*, “Science, Technology, & Human Values”, 41, 3, 2016, pp. 547-565.

this paper, infrastructure is mobilized as a generative term, as an analytic entry into the epistemic infrastructure, the data labour, and the enactment of particular relations in and through pandemic infrastructures²².

Technoscience went together with unprecedented economization of many domains of society, including public health. In many European countries, with new public management and privatization of parts of the health sector, the basic maintenance of core public health and care provision – and in particular its unprofitable groundwork – has been subjected to budget cuts over the past decades and in particular following the 2008 financial crisis²³. The pandemic has exposed this neglect of public health infrastructures, which governments in many western countries had downsized rather than invested in. Interestingly, in the US, public health had actually moved to center stage due to biosecurity concerns following the 9/11 related anthrax attacks. The increased attention, however, took shape with a rather militarized emphasis on biosecurity²⁴. The Bush administration foregrounded concerns about bioweapons, while propagating dual use for drug development and pandemic preparedness²⁵. Infectious disease transformed from a minor theme, dealt with by agencies such as the US Center for Disease Control (CDC), into a national priority, with the prospect of the additional purpose of developing antiviral drugs. The same Dr Fauci that is today widely known as a key public figure of anti-COVID-19 measures advising the US government had then been in charge of building a biosecurity program and biomedical surveillance infrastructure as their core mission, aligned with counterterror programs²⁶. Reconfigured as bioterrorism preparedness, public health institutions encountered the first SARS epidemic, with a response infrastructure focusing on bioweapons²⁷.

While US public health was reframed as matters of national security, the international agencies, such as the WHO had few funding at their dis-

²² This takes up studies that take infrastructure from sanitary or transport infrastructure and knowledge infrastructure to other societal realms, where the work of infrastructuring takes place. See C. Howe *et al.*, *Paradoxical Infrastructures*, cit.; M. Murphy, *Alterlife and Decolonial Chemical Relations*, cit.

²³ See for example S.L. Greer, H. Jarman, R. Baeten, *The New Political Economy of Health Care in the European Union: The Impact of Fiscal Governance*, “International Journal of Health Services”, 46, 2, 2016, pp. 262-282.

²⁴ C. Caduff, *The Pandemic Perhaps. Dramatic Events in a Public Culture of Danger*, University of California Press, Oakland CA 2015.

²⁵ See J. Masco, *The Theater of Operations. National Security Affect from the Cold War to the War on Terror*, Duke University Press, Durham-London 2014.

²⁶ Ivi, pp. 160-161.

²⁷ Ivi, p. 159.

posal and were weakened during the transition from international health to global health²⁸. The latest modifications of thresholds to declaring health emergencies and pandemic situations had again become controversial. When the WHO declared the swine flu pandemic in 2009 and recommended preparations for large-scale vaccine contracting, reviews issued by the Council of Europe and European Parliament criticized this as overreacting and providing unjustified benefits to the pharmaceutical industry²⁹. In addition to decreasing impact of international agencies in a post-Cold War era, the pandemic has cracked open the extent to which state public health systems have lost resources. Global health programs emerged outside of the UN and international agencies, run largely by philanthropic foundations and privately funded initiatives such as the Gates Foundation or the Poverty Action Lab³⁰. These programs are directed to eradicate certain diseases, imposing a strict performance evaluation program and randomized trial evaluation methods. Critics of this mode of global health research have stressed that the focus on quick results visible in performance indicators, often comes at the expense of public health ground work. This prioritizes efficiency of interventions over the less spectacular everyday labour that maintaining community health infrastructures require.

With poor public health infrastructures after years of austerity, calls for digital innovations proliferate and are expected to make up for this lack of funding. Monitoring and scoring systems building on intensified data sourcing for more fine-grained real-time tracking. Given the rapid changes in data practices with digitalization, it is important to understand the relational work of calculative devices, including intensified data sourcing and emergent ‘capture-all’ technologies. Drawing attention to the social stratification effects in these techniques, this paper takes a closer look at the modes of compartmentalizing that continue to shape the calculative infrastructures and modes of aggregating in epidemiology.

²⁸ T.M. Brown, M. Cueto, E. Fee, *The World Health Organization and the transition from “international” to “global” public health*, “American Journal of Public Health”, 96, 1, 2006, pp. 62-72.

²⁹ See D. Cohen, P. Carter, *WHO and the pandemic flu “conspiracies”*, “British Medical Journal”, 2010, 340:c2912.

³⁰ For the Boston-based Poverty-Action Lab (J-PAL), see <https://www.povertyactionlab.org/about-j-pal>

3. *Compartmentalization: Aggregating and enacting liquid population*

A basic epistemic grid is ubiquitous throughout epidemiology to the extent that it is difficult to grasp analytically: the concept of ‘population’. As used in epidemiology, the concept of ‘population’ is concerned less with population growth or the politics of reproduction, but pervasively enacted as part of its epistemic infrastructures. Indeed, the concept of ‘population’ has been holding together the discipline in terms of its ‘population-based’ quantitative study designs, as opposed to ‘individual’ medicine. Having become part of epidemiology’s methodological infrastructure, ‘population’ is not a neutral tool, but entangled with phantasies of population improvement or control and with intervening and governing at the level of population and subpopulations³¹.

At the same time, ‘population’, in certain settings of clinical epidemiology, is used to point to the social dimensions for medical communities working in individual medicine, including ‘critical population health’ research³². Within health sciences epistemic infrastructure, it seems unthinkable to advocate for social medicine without relying on the concept of ‘population’. However, ‘population’ continues to enact a particular mode of biopolitics through aggregations that render masses and crowds manageable. As integral part of the epistemic infrastructure in the social sciences and health policy making, ‘population’ seems available or simply there as pertinent container for knowledge making – and for worries about health matters³³. Deeply entrenched in the methods of epidemiology, ‘population’ is an effect of the epistemic infrastructures and brings about a particular dichotomization of individual/population, which has become perceived as neutral. ‘Population’ has also been mobilized to align with notions of collectives and politics of justice, for instance in formulating a critical population health research³⁴. This, however, does not undo, but continues to enact the concept of ‘population’ and pertinent biopolitical technologies, dichotomizing individual/mass, while affording particular dividual³⁵ – aggregate

³¹ See M. Murphy, *Against Population, Towards Alterlife*, in A. Clarke, D. Haraway (eds.), *Making Kin, Not Population*, Prickly Paradigm Press, Chicago IL 2018.

³² R. Labonte, M. Polyani, N. Muhajarine, T. MacIntish, A. Williams, *Beyond the Divides. Toward Critical Population Health Research*, “Critical Public Health”, 15, 1, 2005, pp. 5-17.

³³ M. Murphy, *Against Population, Towards Alterlife*, cit., pp. 106-107.

³⁴ R. Labonte *et al.*, *Beyond the Divides*, cit.

³⁵ See G. Deleuze, *Postscript on the Societies of Control*, October, 59, 1992, pp. 3-7.

mixtures, amenable to various forms of governance in the tradition of political arithmetic³⁶.

Contemporary epidemiology operates with an epistemic infrastructure shaped by the legacies of colonial public health and Cold War biomedicine and the concept of ‘population’ has been both an effect and foundational category for the discipline. Its basic methodological devices are entrenched in these legacies and actualize them; they containerize health and disease in a specific way, enacting populationalized modes of acting on matters of health and disease³⁷. In this compartmentalization, epidemiology’s apparatus of observation generates a range of measures of disease occurrence and enumeration practices, then uses these measures for purposes of comparison. Disease surveillance and risk assessment evolved through layers of history, and multiply retrofitted and repurposed infrastructure, in terms of data collection techniques, categories, and classifications³⁸. Data sourcing and processing works through compartmentalization into different groups and subgroups, defined by a grid of routinized categories derived from demography. The making of ‘population’ involves aggregation and enclosures, exclusions, and inclusions. Doing this categorization involves meticulous assembling of variables from various sources (health sector, administration, environmental data, socioeconomic registers) and attending to their data structure and interrelations. As new modes of routine pandemic surveillance, these decisions in design and population subgrouping and boundary drawing used in the epidemiological dataset also later contribute to shaping policies and publics.

Like other infrastructure, epistemic infrastructure needs labour and care to be maintained³⁹. This involves shared routines within the discipline of epidemiology in terms of a community of shared practices. An

³⁶ For statistics as political technology, see A. Desrosières, *The politics of large numbers: A history of statistical reasoning*, Harvard University Press, Cambridge MA 1998; T.M. Porter, *Trust in numbers: The pursuit of objectivity in science and public life*, Princeton University Press, Princeton NJ 1995.

³⁷ On classification and containing, G. Bowker, S.L. Star, *Sorting Things Out. Classification and its Consequences*, MIT Press, Cambridge MA 1999; S. Bauer, M. Schlünder, M. Rentetzi, *Boxes. A Field Guide*, Mattering Press, Manchester 2020. On ‘populationalization’, see C. Holmberg, C. Bischof, S. Bauer, *Making predictions: computing populations*, “Science, Technology & Human Values”, 38, 3, 2013, pp. 398-420.

³⁸ G.C. Bowker, Geoffrey C., S.L. Star, *Sorting Things Out. Classification and Its Consequences*, cit.

³⁹ S.L. Star, *Ethnography of Infrastructure*, “American Behavioral Scientist”, 43, 1998, pp. 377-391.

analysis of models and their visualizations featuring in textbook exercises, can help us understand epidemiological thinking and practice. In order to teach and habituate modes of compartmentalizing, health sciences explicate and operationalize ‘population’ through visual analogies. One popular teaching device has been the “bath model”, used to convey and explain measures of disease frequency, especially incidence and prevalence (Fig. 1)⁴⁰. This ‘bath model’ of population, with its input and output streams is different from the ‘urn model’ often used in statistics textbooks to introduce probability theory. The epidemiological analogy of a ‘liquid population’ is more flexible, in terms of changing through input and output flows. It is aimed to deal with a dynamic population, with disease events within a reference population that is not fixed. With a temporal dynamic added in the reservoir model, distinguishing between new (incident) cases and prevalent cases as well as transmission within a dynamic population is habituated, which is important for learning and practicing how to model infectious disease.

Population, here, is enacted as something that can be steered and channelled, managed and governed; despite or rather through its ‘liquid’ character, its data aggregation serves to model and steer a ‘crowd’ by measures steering the flow of data and people. The ‘bath model’ enacts population as an entity that needs to be contained and enclosed. The means of enclosure here focus on the dynamics, on the input and output streams, on what is being added, on treating the population ‘as a whole’ and on making it into an epistemic entity, for which statistical laws can be described and manipulated using an analogy to hydraulics. This mode of thinking taught in epidemiology – and keeping the field together as a discipline – has significant repercussions as to how public health measures are conceptualized. It is a ‘container model’ that underlies and mediates modes of ‘epistemic enclosure’ through study design and numerical abstracting.

Like hydraulic economic models of money flow emerging at about the same time, these analogues enact particular connections and characteristics – streams of data, capital, and people can be brought in analogy using sociotechnical imaginaries of corresponding ducts⁴¹. Through epidemiology’s ‘bath model’, social engineering is designed following hydraulics im-

⁴⁰ R.S. Bhopal, *Concepts of Epidemiology*, Oxford University Press, Oxford 2002, p. 186.

⁴¹ M.S. Morgan, M. Boumans, *Secrets Hidden by Two-Dimensionality: The Economy as a Hydraulic Machine*, in S. de Chadarevian, N. Hopwood (eds.), *Models. The Third Dimension of Science*, Stanford University Press, Stanford 2004, pp. 369-401.

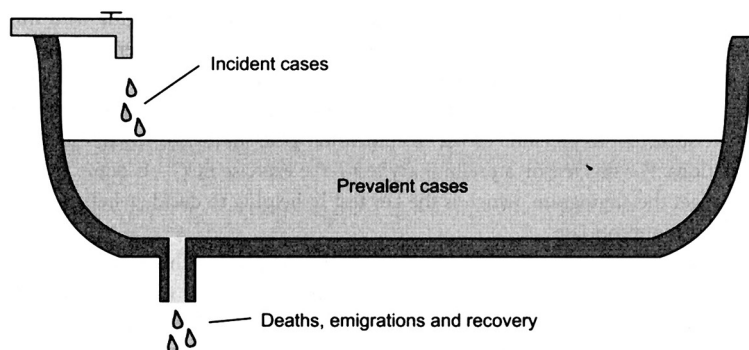


Fig. 7.6 Incidence, prevalence, and the bath model of disease (Adapted from a figure provided by Howel, see Permissions).

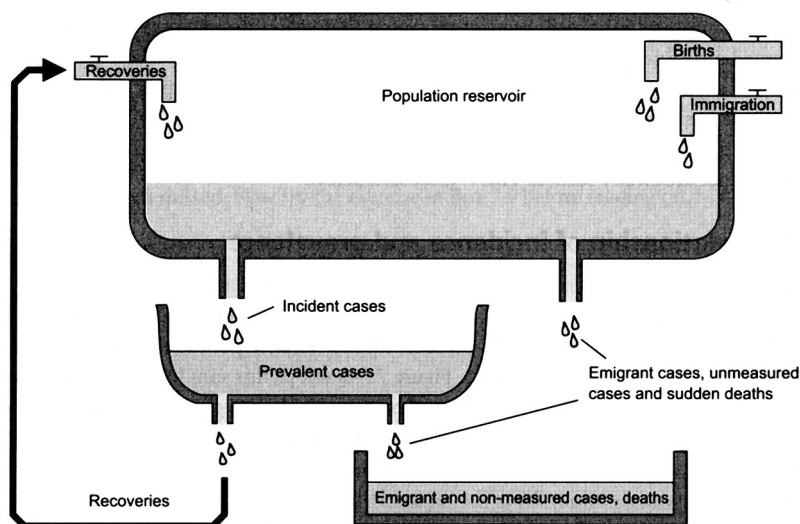


Fig. 7.7 Incidence, prevalence in a natural population: the population reservoir.

Fig. 1. Liquid population. Epidemiology textbook's "bath model", explaining the difference of prevalence and incidence and habituating population thinking (source: Bhopal 2002, see note 40).

aginaries. How statistical relations materialize is dependent on data collecting, routinized categories, and modes of compartmentalization. Key

categories activated when these models are put to use for tracking pandemic developments are (nation) state systems of reporting and assessing, which afford specific national responses. The model affords manipulations to the system, for instance in response to a pandemic, in terms of modifying enclosures and as tinkering with the categorization of groups and the model's input and output streams.

Take the models used in infectious disease epidemiology, referred to as "SIR model", which operationalize 'population' as a totality, made up of three different compartments: susceptible, infectious, and recovered. Based on this compartmentalization, the mathematical model describes and predicts the movement in and out of these compartments, with rates assumed to be constant or estimated⁴². To be validated with data, infectious disease modellers also translate these tools to guide policy making, to predict and compare effects of particular intervention measures (including vaccination strategies), based on current data of prevalence, transmission, and immunization rates. Compartmental models are a key epistemic infrastructure, developed for studies of smallpox and pandemic strains of influenza A.

Such model traditions and compartmentalization at epidemiology's disposal have been mobilized and activated in today's knowledge base to address the COVID-19 pandemic. Containers and compartmentalization were also activated in the epidemiological responses to the COVID-19 pandemic. This included those sociotechnical imaginaries of engineering the economy in a stratified mode, using immunity-status to protect elites and assign citizens to maintain certain sectors or receive privileges. From the early phase of the pandemic – even in the absence of vaccines – ideas of "immunity passports" were proposed, which prompted controversy as they incentivized infection and reinforced divisive relations of "immuno-privilege"⁴³.

⁴² M. Kretzschmar, *Infectious Disease Modeling*, in K. Heggenhougen, S. Quah (eds.), *International Encyclopedia of Public Health*, 3, Academic Press, San Diego 2008, pp. 569-576.

⁴³ For a discussion of 'immunity passports' and 'vaccine passports' respectively, see for instance R.C.H. Brown, J. Savulescu, B. Williams *et al.*, *Passport to Freedom? Immunity Passports for COVID-19*, "Journal of Medical Ethics", 46, 2020, pp. 652-659; T. Osama, M.S. Razai, A. Majeed, *COVID-19 Vaccine Passports: Access, Equity, and Ethics*, "British Medical Journal", 2021; 373, 2021, n861 doi:10.1136/bmj.n861; C.H. Liew, G.T. Flaherty, *Immunity Passports to Travel during the COVID-19 Pandemic: Controversies and Public Health Risks*, "Journal of Public Health (Oxf)", 43, 1, 2021, e135-e136; J. Liz, *COVID-19, Immunoprivilege and Structural Inequalities*, "History and Philosophy of the Life Sciences", F43, 1, 2021, 19; B. Ajana, *Immunitarianism: Defence and Sacrifice in the Politics of COVID-19*, "History and Philosophy of the Life Sciences", 2021 Feb. 22;43(1):25.

As the visual model reprinted in Fig.1 conveys to the students of epidemiology, there are ‘bottlenecks’ and other steering options that can be used to control incident cases, which then, almost as a reflex, is translated into the measure of preventing ‘inflow’ through means of border closing. In the COVID-19 pandemic, this was exacerbated, especially given the lack of a joint EU response in the early phase of the public health responses before testing and tracing was established. Despite a certain public health rhetoric, infrastructural work does not necessarily foster solidarity, but evokes and prompts border closings, reinforcing the “us versus them” rhetoric, inclusion, and exclusion. Solidarity also becomes compartmentalized, and restricted to those within national borders.

In the era of digitalization and the expectation of digital solutions, new devices participate in compartmentalization. Online dashboards have become important interfaces for epidemiological monitoring, tracking and visualizing numbers of infections. Taking the cue from Verran’s notion of “decomposing numbers” and engaging with the realm of indexing⁴⁴, the next section begins to diffract and decompose three instances of apparatus: online dashboards, database recombination, and sewage epidemiology.

4. *Dashboards: Tracking devices and epidemic indexing*

Since early on in the COVID-19 pandemic, online dashboards appeared in the public sphere⁴⁵. These tracking and reporting devices, built on geographic information systems (GIS) technologies, are continuously updated by recording, counting, and storing information on cases from defined sources, with the goal of getting as close to real-time numbers as possible. During the pandemic, millions of people looked at these semi-automated maps, checking numbers every day. What kind of orderings, compartmentalization, and densities do these public health surveillance devices enact?

The term ‘dashboard’ has gained currency with digitalization and smart city projects, while its genealogy takes us to control units for cars, but also to cockpits and control rooms of reactors, large water management sys-

⁴⁴ H. Verran, *The Changing Lives of Measures and Values: From Centre-Stage in the Fading ‘Disciplinary’ Society to Pervasive Background Instrument in the Emerging ‘Control’ Society*, “The Sociological Review”, 58, S2, 2012, pp. 60-72; Id., *Decomposing numbers*, “HAU: Journal of Ethnographic Theory”, 8, 1-2, 2018, pp. 23-26.

⁴⁵ See the one by Johns Hopkins University, published first on 22 January, see Lancet 20 correspondence E. Dong *et al.*, *An Interactive Web-Based Dashboard...*, cit., pp. 533-534.

tems, or industrial processes. Dashboards are means for data gathering and evidence-based policy-making. They function as data-driven public steering practices and they are able to render public relations otherwise invisible⁴⁶. At the beginning of the pandemic, coronavirus dashboards were often an immediate response, partly initiated in academia by schools of public health, then international agencies, and later on also by regions and municipalities. With diverse funding from research organizations, philanthropy, government, and charities, these dashboards collect and visualize data on COVID-19 cases, deaths, tests, hospitalizations, and more recently, vaccinations, with the goal to “help the public, policymakers, and healthcare professionals worldwide respond to the pandemic”⁴⁷.

Widespread datafication, number-making, tracking, and visualizing through dashboard, recently also led to the emergence of ‘data journalism’, which is reporting on and producing enumerative online tools. Initiatives like the Oxford-based “Our World in Data” list COVID-19 statistics, as part of a much larger effort of sharing data and statistics openly. WHO, as part of health surveillance, collates COVID-19 data or the frequently cited Johns Hopkins University (JHU) coronavirus dashboard (Fig. 2)⁴⁸. In addition, news agencies and media have established their own data sourcing and reporting schemes. That WHO numbers are but one data source within scientific and public debates over policy recommendations points to an increasing number of actors, much beyond UN agencies. With increasingly distributed infrastructures in data science and calculative platforms, close studies of apparatus seem even more important. Visual and numerical renderings generated through dashboards – inscriptions as products of apparatus – are reassembled⁴⁹. This specific apparatus of observation is not contained in one lab or fully standardized research infrastructure, but mostly heterogeneous, contingent and distributed. To examine this further, we will take a closer look at the JHU online dashboard.

As a counting device, the JHU coronavirus dashboard⁵⁰ brings together numbers from different sources on one screen. Comparability of num-

⁴⁶ A. Desrosières, *The Politics of Large Numbers*, cit.

⁴⁷ JHU Coronavirus Resource Center. <https://coronavirus.jhu.edu/about>

⁴⁸ *Ibidem*.

⁴⁹ B. Latour, S. Woolgar, *Laboratory Life*, Princeton University Press, Princeton NJ 1987; K. Barad *Meeting the Universe Halfway*, cit.

⁵⁰ E. Dong *et al.*, *An Interactive Web-Based Dashboard...*, cit., pp. 533-534. The platform aggregates data from multiple sources from different countries and their agencies. There are a number of international websites giving global numbers, such as WHO, “the world in data”, world in numbers and diverse press agencies drawing on data science and data journalism as emerging professional fields in journalism, some reporting slightly different kinds of summary statistics.

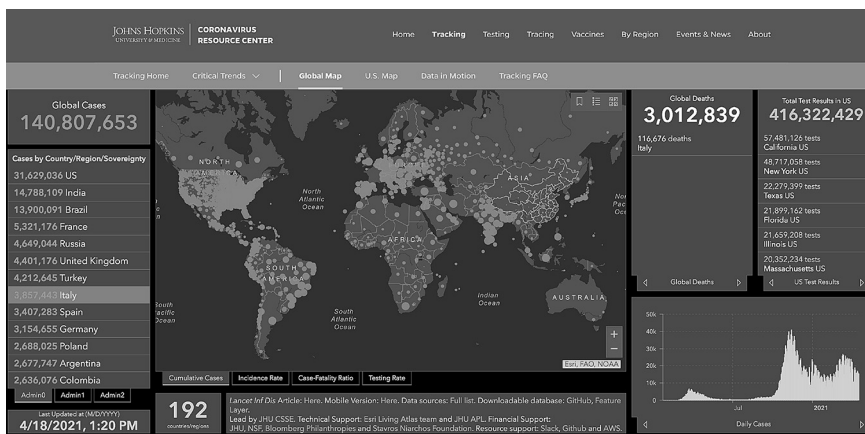


Fig. 2. Global COVID-19 tracking. Semiautomatic pandemic data streams (source: Johns Hopkins University (JHU) Coronavirus Resource Center; screenshot of the JHU COVID-19 Dashboard, April 5, 2021).

bers within tables and visualizations is limited due to differences in resources and administrative routines, resulting in a heterogeneous morphology of reporting. In its global tracking version, the dashboard lists absolute numbers, for incidence and mortality. The JHU dashboard also features visual maps (Fig. 2). The map displays how the SARS-CoV-2 virus and the pandemic's epicenters, as several epidemic surges, described as 'waves', move from within Asia to Europe, North America, South America, and by May 2021 to India. The dashboard's main world map builds on the Mercator projection, a colonial era mapping technique in marine navigation which depicts areas far from the equator, like North America and Europe, as much larger in relation to equatorial countries, often truncating parts of the southern hemisphere. Initially, dots denoting case numbers appeared on more and more places and allowed to track the global spread of disease from region to region; once the pandemic has spread globally, with growing numbers and overlapping visual icons, those maps provide little information.

The first column on the left of the dashboard lists its main category: "cases by countries, regions, sovereignty" – which functions as a main organizing grid within the dashboard's enumerations. Mainly composed of states, underreporting and overwhelmed public health systems have been

an issue for countries of the global south⁵¹. Over time, the main compartmentalization enacted is the universalized grid of the nation state, territorializing the pandemic in a particular way⁵². The compartmentalization affords national aggregations and stratified population governance. Indeed, the pandemic surge goes together with a surge of the nation state, a compartmentalization of the pandemic, with national-level response and vaccination strategies and border regimes.

The list to the left-hand side is continuously updated and ranked by absolute numbers for confirmed infection cases. This number, however, is not suited for country comparisons, since it is not reported in terms of incidence rates per 100.000 residents. Therefore, countries with smaller numbers of inhabitants, but high incidence would not feature at the top. Absolute numbers are still highly relevant for public health systems, in terms of cases healthcare systems need to provide contact tracing, and hospital care. In addition, for country comparisons of mortality, mortality rates (numbers per 100.000) need to be searched for in another section of the dashboard, under the rubric “data visualizations” and “critical trends”⁵³. In public reporting throughout the pandemic though, when referring to the JHU website, the focus has been on large absolute numbers, often out of context in rather sensational reporting for countries with large population numbers.

A key aspect of generating valid epidemiological disease counts, like the ones displayed in an online dashboard, is case ascertainment. This refers to standardized procedures of what counts as COVID-19, in testing, diagnosis and recording mortality. What are the diagnostic criteria and what documentation is needed to count a case as case for this dashboard? How do testing rates modify the numbers? In her 2020 discussion of the JHU dashboard, historian of science Ilana Löwy reminds us of the myriad of decisions involved in diagnosing a case and how this is not just a count, but an outcome of a complex apparatus of observation and measurement procedures within a diagnostic procedure⁵⁴. Even once a standardized

⁵¹ While in mid-2021 India reported a surge in incidence and mortality, Turkmenistan never reported data, as it claimed to be unaffected by Covid-19 and others paused or stopped their counts. For instance, Tanzania a few months into the pandemic, stopped reporting numbers, with case numbers just remaining at 509 since.

⁵² Some non-state entities also feature in the list – these are Diamond Princess and MS Zaandam, the cruising vessels affected in the early phase of the pandemic, but remaining in the list, as extraterritorial entities.

⁵³ <https://coronavirus.jhu.edu/data/mortality>

⁵⁴ I. Löwy, *Ludwik Fleck Where Are You Now That We Need You*, “Somatosphere. Science, Medicine, and Anthropology”, 16 October 2020.

methodology emerges from a collective effort in research, there may still be disagreement both within and between thought collectives. The work of selecting the indicators, establishing and visualizing them is key to calibration of a test. Here, calibration can refer to any single testing technology and indicator or visualization, but is also highly relevant for the dashboard as a whole. Fleck's work, as Löwy explicates for the case of PCR diagnosis, opens up for a more nuanced account, in terms of following the linkages a test technology enacts, foregrounds, gives up on, or plays down.

Dashboards are a powerful apparatus of observation in two ways, as they participate in world making, machine-mediated diagnosis, and affective economies: First, as they are ordering the social in evidence-based governance and, second, as they become infrastructural as decision-support tools. The data visualizations provided inform collective sense making and getting accustomed to case numbers: With calls to "flatten the curve", a 'terrible number' on one side of the curve can be met as 'quite a relief' on the other side of the curve. Reports of rising mortality (known to increase 2-4 weeks after incidence peaks) are met with resignation and fatalism, or just routinized. Within Europe, for example, already from the start of the pandemic, the ways in which it was met in different ways. Some governments' first concerns were how to secure equipment and expand intensive care infrastructures – other governments' primary concern was *who* should get available resources and, consequently, in a biopolitic or necropolitic of who must die⁵⁵. During Europe's second wave of COVID-19 in late 2020, politicians rushed, often under pressure of upcoming elections, to relieve restrictions as soon as incidence rates began to stop growing exponentially. Once case numbers became routinized, the formerly preventable deaths, as they occur with a time lag after a rise in incidence numbers, began to appear unavoidable. Meanwhile, on the longer term, new SARS-CoV-2 mutations require modifications to the model predictions, as well as provide experimental opportunities for new data platforms. "Machine diagnosis"⁵⁶, as visual cultures scholar Ramon Amaro uses the concept in his genealogy of calculus and government forecasting, as one informed by political arithmetic, indeed applies at more-than-individual level.

Different from political arithmetic, online dashboards bring statistical data into the public realm, changing the configuration of the epidemio-

⁵⁵ A. Mbembe, *Necropolitics*, Duke University Press, Durham 2019.

⁵⁶ R. Amaro, *Machine diagnosis*, cit.

logical gaze into a more synoptic⁵⁷ control room, for both professionals and for the broad public. Asking whether this works toward democratization of expertise and broader public deliberation might miss the point of infrastructural agency in these techniques. What the extension of institutional transparency assembles, rather seems similar to ‘control room publics’, affirming a universalizing apparatus in heterogeneous worlds. As dashboards become more permanent interfaces, they configure the ways in which policymakers navigate the pandemic, limiting what indicators are available and deemed relevant. While there is heterogeneity in case ascertainment and completeness of records and data processing, these universalized reporting machineries and their numbers and visuals bear agency, especially as they work in the sense of quasi-‘capture all’ formations. While a virus prompted the making of dashboards, the pandemic as a phenomenon also gets ‘techno-digested’ as it enters and travels through human-made infrastructures, such as data repositories.

5. *Recombinatory sense making: Repurposing genetic databases*

Making sense of the COVID-19 pandemic in the era of digitalization is not restricted to online dashboards; it mobilizes a broad range of life sciences techniques. The virus moves through epistemic infrastructures, technological batteries and data repositories at hand. The COVID-19 pandemic provides opportunities to showcase relevance to some of those data repositories established during the promissory era of genomics⁵⁸.

On September 30, 2020, a preview of a Nature article boldly claiming that “The major genetic risk factor for severe COVID-19 is inherited from Neanderthals”⁵⁹. The presented research ventured into the exploration of genetic risk factors for the differential disease response to the virus by different groups of people. For their paper researchers used available databases in order to investigate risk genetic factors for severe COVID-19, after early studies had already identified certain genetic regions on

⁵⁷ Building on Michel Foucault’s work, surveillance studies scholars have coined the terms oligopticon and synopticon to describe the changing surveillant gaze. On the notion of synopticon, see: T. Mathiesen, *The Viewer Society: Michel Foucault’s Panopticon” Revisited*, “Theoretical Criminology”, 1, 2, 1997, pp. 215-234.

⁵⁸ M. Fortun, *Promising Genomics. Iceland and deCODE Genetics in a World of Speculation*, University of California Press, Berkeley 2008.

⁵⁹ H. Zeberg, S. Pääbo, *The major genetic risk factor for severe COVID-19 is inherited from Neanderthals*, “Nature”, online 30 September 2020, doi: 10.1038/s41586-020-2818-3.

the genome to be associated with COVID-19. Based on studying haplotypes, combinations of genetic variation, are examined with respect of whether carriers of certain haplotypes (a combination of genetic variations) are potentially at increased risk for severe COVID-19. What emerged as possible markers, were some regions on chromosome 9 that determine the ABO blood groups as well as haplotypes on chromosome 3 also known from previous studies to be found in genetic material from Neanderthals. The study looked into the known haplotype characteristic in ancient DNA as well as in different population groups, genetically mapped and known from those infrastructure projects human genetic diversity scientists work with, for example the HapMap Project.

Genomic databases, such as the HapMap Project and the 1000 Genomes Project were projects of data collection and inventory. Repurposed during the COVID-19 pandemic, scientists now interrogated those databases to find genetic risk factors for severe COVID-19, as a means to speak to prevention and health care provision by identifying potentially vulnerable groups research questions about risk factors for severe COVID-19, with the goal of improving prevention and health care provision by identifying and targeting vulnerable groups. Techniques such as genome-wide association studies and computational biology were put to use, linked up and recombined with other information, stockpiled in these digital information repositories. Through linkage analysis, scientists determine in which of the studied groups (as categorized in their databases) and where “risk haplotypes” (particular variations on the genome shared by patients with severe COVID-19) correspond to haplotypes found in Neanderthal samples and, according to the scientists, this group was found most closely linked with the Croatia Vindija Neanderthal⁶⁰. This is interpreted as pointing to the group possibly at a higher statistical risk than others, as there is geographic variation in the proportion of humans carrying this haplotype. The authors estimate these proportions at 50% in South Asia and 16% in Europe today, simultaneously bringing COVID-19 risk characteristics in connection with alleged genetic clues to ancient human migration history. In these knowledge-building practices, haplotypes function as entities that draw together COVID-19 patients, ancient samples from Southern Europe (Croatia) and Southern Siberia (Altai Mountains)⁶¹.

For these studies, comprehensive projects, such as the Human Genetic Diversity Project, the HapMap Project, the 1000 Genomes Project, and

⁶⁰ *Ibidem.*

⁶¹ *Ibidem.*

similar stock taking initiatives, including the databases and biobanks make up the current knowledge base of genomics. Their digital and material repositories have become infrastructural to what postgenomic biosciences are and how they are being put to action and made relevant as a cutting-edge resource to speak to the scientific sense-making of the COVID-19 pandemic. Evolutionary biologists and geneticists identify some of these databases as available means to scientifically tackle a problem. This refers also to issues of monitoring and available battery of tools for sense-making. Sensemaking hence is always related to infrastructures, methods, toolboxes, empirical strategies, databases and study designs. Take the example of omics technologies, a term for the set of technologies developed from and reaching far beyond the human genome project. The latter once was designed to sequence the human genome, then turned into studies of genetic differences, such as single nucleotide polymorphisms, as markers that could be mapped for disease susceptibility as well as to make conclusions about human origins, migration histories.

This mode of knowing and sense making works through mining and reshuffling previous scientific infrastructures and categories. This mode of repurposing could be referred to as a retrofitted “epidemic of signification” of its own, another voice in response to the pandemic, in a sound science speculative move, using genomics databases at hand⁶². A speculative mode of science on the one hand or, turned the other way around, the virus SARS-CoV-2 meandering through and aligning with existing epistemic infrastructures.

6. *Passive sampling: Sewage-based epidemiology*

Water and sanitation systems have played a key role in epidemiological research, from the textbook case and seminal work by 19th century epidemiologist John Snow on cholera and the Broad Street pump supplying water to the district⁶³. New analytic techniques have rendered sanitation systems – here sewage systems – and the human excretions they contain – as a promising source of information on public health and epidemic surveillance. In studying excretions contained in wastewater and present in

⁶² For the notion of “epidemic of signification”, see P.A. Treichler, *AIDS, homophobia and biomedical discourse*, cit.; S. Bauer, *Indexing, Coding, Scoring*, cit.

⁶³ J. Snow, *Cholera and the Water Supply in the South Districts of London in 1854*, “Journal of Public Health and Sanitary Review”, 2, 7, 1856, pp. 239-257.

sewage systems, epidemiologists take advantage of this access to human biological materials through sanitation systems, establishing an entirely new field: sewage-based epidemiology.

Human biological samples are usually taken in medical institutions and as part of biomedical research or healthcare provision, where individual human biological material is a scarce resource stored and taken care of in biobanks under ethics protocols and strict governance regimes. Viral loads can not only be measured through testing for citizens or in medical settings, but also in more mundane, less individual-level modes, within sewage in residential areas, containing excrements of entire neighbourhoods. Environmental health researchers and epidemiologists have developed techniques that take advantage of the biological materials available in cities' sewage systems. These practices take part in reassembling inscription devices and surveillance techniques for viral monitoring, tracing viral infections through bodily excretions by sanitation infrastructure in residential areas. This mode of mapping enables remote surveillance in a 'capture all' sampling approach and puts to work a spatial grid used for governance and delineating measures as well as informing public health responses⁶⁴.

Wastewater-based epidemiology gained momentum, as it was used to estimate COVID-19 infection without enrolling individuals into medical testing or screening in population studies⁶⁵. To enable comprehensive sewage-based biosurveillance, researchers organize collaborative work to develop standardized methods, digital collaborative tools and platforms for pandemic monitoring⁶⁶. Previously, this epidemiological approach, referred to as "wastewater fingerprinting" has been applied to track medications, health status as well as pathogens and antimicrobial resistance⁶⁷. As "Sewage Biological and Chemical Information Mining", such ap-

⁶⁴ T. Prado, T.M. Fumian, C.F. Mannarino, P.C. Resende, F.C. Motta, A.L.F. Eppinghaus, V.H. Chagas do Vale, R.M.S. Braz, J.D.S.R. de Andrade, A.G. Maranhão, M.P. Miagostovich, *Wastewater-Based Epidemiology as a Useful Tool to Track Sars-Cov-2 and Support Public Health Policies at Municipal Level in Brazil*, "Water Res.", 2021, 191:116810.

⁶⁵ G. Orive, U. Lertxundi, D. Barcelo, *Early Sars-Cov-2 Outbreak Detection by Sewage-Based Epidemiology*, "Science of the Total Environment", 2020, 732:139298; S. Agrawal, L. Orschler, S. Lackner, *Long-Term Monitoring of Sars-Cov-2 Rna in Wastewater of the Frankfurt Metropolitan Area in Southern Germany*, "Nature Scientific Reports", 11, 1, 2021, 5372.

⁶⁶ A. Bivins, D. North, A. Ahmad *et al.*, *Wastewater-Based Epidemiology: Global Collaborative to Maximize Contributions in the Fight Against COVID-19*, "Environmental Science & Technology", 54, 2020, pp. 7754-7757.

⁶⁷ M. Lorenzo, Y. Picó, *Wastewater-Based Epidemiology: Current Status and Future Prospects*, "Environmental Science and Health", 9, 2019, pp. 77-84.

proaches have been used for sampling for community-based SARS-CoV-2 analyses⁶⁸. With faster techniques for PCR-based analyses available, this mode of biosensing has been promoted as non-invasive sampling approach, and early warning system⁶⁹. Work on standardization is ongoing, in order to tackle issues of comparability of measurements, establish sampling logistics, manage the temporalities, and assess conditions of dilution and persistence of the virus outside living organisms and which adaptations analytic techniques may need. Standardized and workable procedures for sampling and analysis are worked on and calibrated, since current test kits were developed for the purpose of medical diagnostics and not for measurements in environmental samples.

As a mode of passive sampling, sewage-based real-time monitoring may reshape stratified urban spaces and the momentum of community surveillance. A technique developed for environmental surveillance of toxic pollutants and envisioned as predictive tool where population studies are too difficult, it is used to complement the toolbox of environmental health monitoring. At the same time, this mode of community biosurveillance nurtures capture-all-in-real-time imaginaries, aligning well with current trends in intense datafication. As “multi-omics” vision, these efforts envision surveillance of the microbiome and the metabolome for “residential catchment” areas⁷⁰. Sewage-based epidemiology has been used to estimate “the collective illicit drug use in a community”, for instance in relation to the opioid epidemic in the US⁷¹. Scientific practitioners, aware that this kind of surveillance produces ethical dilemmas, have developed guidelines on how to account for “ethical risk factors” and prevent stigmatization, for instance in site-based studies including schools, prisons, and workplaces⁷². Delineating the sites and catchment areas for capture-all monitoring and aligning wastewater infrastructures with health monitoring may set off a broader reshuffling, often reinforcing social stratification. Aware that, in the case of drug biosurveillance such practices can stigmatize entire neighbourhoods, researchers propose communication

⁶⁸ S. Mallapaty, *How Sewage Could Reveal True Scale of Coronavirus Outbreak*, “Nature”, 2020, 580(7802), pp. 176-177.

⁶⁹ G. Orive *et al.*, *Early SARS-CoV-2...*, cit.

⁷⁰ Matus M. *et al.* 2019. 24-hour multi-omics analysis of residential sewage reflects human activity and informs public health, bioRxiv preprint doi: <https://doi.org/10.1101/728022>.

⁷¹ S. Salvatore, J.G. Bramness, M.J. Reid, J. Malcolm, K.V. Thomas; Harman, P. Christopher, J. Roislien, *Wastewater-Based Epidemiology of Stimulant Drugs: Functional Data Analysis Compared to Traditional Statistical Methods*, “PLOS ONE”, 10, 9.

⁷² <https://score-cost.eu/ethical-guidelines-for-wbe/>

strategies about goals and purpose of the studies, as well as community stakeholder dialogue, and protection of anonymity. Quests for comprehensive biosurveillance epitomize the simultaneity of care and control in public health. In a transnational take, how the virus moves through bodies and sewage is already socially stratified and so are the available public health resources. Calls for more biosurveillance leave both societal and environmental inequities where they were, if not amplifying how the SARS-CoV-2 inequitably affects different groups.

7. Conclusions

More than a year into the global COVID-19 pandemic, a virus and its mutations have shaken up everyday lives, with unequal and highly stratified consequences. Epidemiological models and numbers circulate in the public domain to an unprecedented extent. Models are more than just scientific struggles over representation of the best or the most workable depiction of reality. They actualize epistemic legacies and enact particular modes of ordering. This paper has been concerned with examples of calculative devices mobilized to feed into pandemic response, which mediate and co-shape truth speaking and policy responses. Crafting public health response uses digital technologies, such as dashboards, database recombination, and wastewater surveillance, prompting a host of rather invisible shifts. The focus on apparatus has been an attempt to better understand some of the lynchpins driving pandemic response and shaping future epidemiological infrastructures.

From 'container models' and population compartmentalization to semi-automated dashboards for tracking cases, this paper has examined the application of capture-all monitoring and sense making of the pandemic. While epidemiological models of liquid population historically mobilized hydraulics as guiding vision for engineering, they continue to shape epidemiology's mode of compartmentalizing. This includes optimization techniques that continue to rely on the concept of 'population' that has been pervasive from social medicine to eugenics and from medical geography to population health and technologies of the self. More than mere metaphors, these model exercises habituate the thinking and the ways in which societies act on the pandemic. Conceived as container for liquid population, tracking devices enact the 'nation state'. Deploying the options offered by the model, governments prioritize border closing as a first measure over transnationally or regionally coordinated responses – even when variations

within countries exceeded variations between countries. During the covid-19 pandemic, new developments every single day make it difficult to contain an analysis. Rather they render visible more layers of inequity in global health, regarding access to testing, vaccine nationalism in the global north, pursuing vaccine diplomacy merely as an add on.

As virus and pandemic travel through existing infrastructures, the very categories of compartmentalization prompt societies to respond in specific ways. New research in automation, metabolomics, and digital epidemiology are reconfiguring epidemiological research practices. In efforts toward transparency and to establish trust, governments and scientific institutions make available data to the public. Yet, epistemically, epidemiology's imagined publics continue to be conceptualized as passive subjects in public health, enacting collectives as populationalized remote object of health surveillance. For the sake of controlled knowledge regimes and fixed designs, citizens feature as blinded individuals in large numbers, which has been solidified into the very epistemic infrastructure of expert public health knowledge for response and prevention.

Attempts to initiate epidemiology from below have remained marginalized, by its very epistemic framework that put study participants in a position of methodologically sanctioned atomized individuals within a population statistic. Working toward "infrastructure literacy", as has been proposed in the case of data processing and social media⁷³, may be key to make room for a broader deliberation on technologies such as pandemic tracking devices. Instead of these exclusions, which amplify societal divides, such efforts could work to reformulate a more "participatory epidemiology"⁷⁴. Decentring epistemic infrastructure and reconfiguring the technoscience apparatus of epidemiology could mean to make room for interventions and reconfigurations into scientific practices toward an epidemiology of commons.

Compared to the climate crisis, the COVID-19 pandemic brought about sudden disruptions and unprecedented 'acuteness', changing mobility patterns and adding new segmentations upon existing ones. The scale of pandemic disruption of everyday life may be new to the recent public memory of western citizens. However, post-Cold War societies, postcolonial societies, and indigenous communities have long had to deal with more severe disruption – be it 'transitioning' from late socialism to

⁷³ J. Gray, C. Gerlitz, L. Bounegru, *Data Infrastructure Literacy*, "Big Data & Society", July 2018. doi:10.1177/2053951718786316.

⁷⁴ P. Brown, *Popular Epidemiology Revisited*, "Current Sociology", 1997, 45, 3, pp. 137-156.

neoliberalism, living with austerity measures or under structural adaptation programs, and the long aftermath of colonialism and settler colonialism. Different from infectious diseases like tuberculosis, malaria, or Ebola epidemics in the global south, COVID-19 pandemic and avoidable death toll hitting also Europe and North America, prompted unprecedented response in terms of protection measures and economic backing. The COVID-19 pandemic also reassembled epidemiology, its calculative devices and pertinent policy responses – now that a virus moved both through epidemiology’s quasi-experimental infrastructures and reached unprecedented public presence. A collective surveillant gaze and infection numbers out in the public – with everyone watching everyone – has replaced the clinical gaze and the panopticon of surveillance medicine has transmogrified into a “synopticon” of epidemiological monitoring⁷⁵.

With the current pandemic, we have witnessed how something that has long been evoked as a vague prediction by global health researchers: the return of infectious disease, showing how a viral pandemic exacerbates health inequities and societal divides. In addition to assertions that “nobody is safe until everyone is,” decolonial scholarship has long reminded us that, many indigenous people already live in a postapocalyptic state caused by modernization projects⁷⁶. The COVID-19 crisis exposes the inequitable positioning in the technoscientific labour to cope with the pandemic, unequal geographic distribution of experimental labour by vaccine trial subjects and actual beneficiaries of trial results. The global pandemic results in specific containments, leading to new societal stratification and segmentation, adding just another layer of disparity. Much is at stake regarding future calculative infrastructuring, stratification effects in modes of accounting, and accountability. Focusing on pandemic apparatus may help us counteract and intervene in the violent stratifications that have been a part of epidemiology’s colonial and Cold War legacies. Moreover, this makes room for engaging differently and more symmetrically with inequitable public health matters and for decomposing and eventually recomposing the ways of knowing in public health.

⁷⁵ See: T. Mathiesen, *The Viewer Society: Michel Foucault’s “Panopticon” Revisited*, “Theoretical Criminology”, 1, 2, 1997, pp. 215-234.

⁷⁶ See, for instance, K.P. Whyte, *Our Ancestors’ Dystopia Now: Indigenous Conservation and the Anthropocene*, in U.K. Heise, J. Christensen (eds.), *The Routledge Companion to the Environmental Humanities*, Routledge, New York 2017, pp. 206-215; K. TallBear, *Caretaking Relations, Not American Dreaming*, “Kalfou: A Journal of Comparative and Relational Ethnic Studies”, 6, 1, 2019.

The epistemic values at the basis of epidemiology and public health

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Abstract: In the middle of the severest public health crisis of the 21st century thus far, scholars in the humanities and health and social sciences have accelerated their reflections about public health, its evidence base, its normative dimensions, as well as its successes, failures and pitfalls. In this paper, we aim to contribute to this global thinking about public health by focusing on one particular aspect, namely its dependence on epidemiology as the main generator of evidence for public health interventions and policy. Our argument is that while it is undeniable that epidemiology (and its sub-fields) have made very many significant contributions both to enlarge our knowledge of disease and its causation, prevalence and incidence, and to channel public health interventions, it also has its limits. The limitations of epidemiology lie in the (implicit) epistemic assumptions which involve focusing on (aggregates of) individuals, and obscures the key role of the social level of analysis. These limitations, however, are also an opportunity to highlight and rethink a more distinctly social approach to health and disease, and one that is genuinely population in character. Our argument applies broadly, but the COVID-19 pandemic makes it an urgent topic to address.

Keywords: COVID-19; mixed-mechanisms; disease causation; epidemiology; social epidemiology; social-to-biological transition; public health interventions; epistemic values

1. Introduction

In recent years a number of philosophers have turned their attention to ethical, epistemological and methodological questions arising from the

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practice of epidemiology and public health¹. The definition of public health is broad – the science and art of preventing disease, prolonging life, and improving quality of life through organized efforts and informed choices of society, organizations (public and private), communities and individuals². It involves disease prevention, health protection and health education and promotion³. This embraces a wide number of disciplines from virology and bacteriology, through the social and behavioural sciences, to management and political and policy science. However, epidemiology and its associated statistical methods, have been pre-eminent in the public health canon. Training in epidemiology is at the heart of public health education and the academic activity called public health. The practice of public health in the field and the community, has to pay close attention to the behavioural, management, and other disciplines, but the dominance of epidemiology in the academy creates a paradigmatic world view, the weakness of which has been revealed in the current COVID-19 pandemic. It has been argued that the science that has guided governments during the pandemic has been driven mostly by epidemic modelers and infectious disease specialists⁴. We suggest that, in the severest public health crisis of the twenty first century thus far⁵, one of the reasons why the voice of public health has not been as powerful as it should have been has to do with the epistemic frameworks and evidence base coming from epidemiology.

This is not to propose that epidemiology is unimportant. Quite the contrary. However, we do argue that there is an epidemiological way of

¹ A. Broadbent, *Philosophy of epidemiology*, Palgrave Macmillan, Basingstoke 2013; O. Dammann, *The etiological stance: explaining illness occurrence*, “Perspectives in biology and medicine”, 60, 2017, 2, pp. 151-165; A. Dawson, M. Verweij (eds.), *Ethics, prevention, and public health*, Clarendon Press, Oxford-New York 2009; F. Russo, *Causal webs in epidemiology*, “Paradigm”, XXIX, 2011, 1; T. Schramme, *Health as notion in public health*, in *Handbook of the philosophy of medicine*, T. Schramme, S. Edwards (eds.), Springer Netherlands, Dordrecht, pp. 1-10; T. Schramme (ed.), *New perspectives on paternalism and health care*, Springer International Publishing, Switzerland 2015; J. Stegenga, *Medical nihilism*, Oxford University Press, Oxford 2018; D. Teira, J. Reiss, *Causality, impartiality and evidence-based policy*, in *Mechanism and causality in biology and economics*, H.K. Chao, S.T. Chen, Roberta L. Millstein (eds.), Springer Netherlands, Dordrecht 2013, pp. 207-224; S.A. Valles, *Philosophy of population health science: philosophy for a new public health era*, Routledge, New York 2019.

² C.E.A. Winslow, *The untitled fields of public health*, “Science”, 51, 1920, 1306, pp. 23-33; World Health Organization, *WHO definition of public health*, 2021.

³ A. Tannahill, *What is health promotion?*, “Health Education Journal”, 44, 1985, 4, pp. 167-168.

⁴ R. Horton, *Offline: COVID-19 is not a pandemic*, “The Lancet”, 396, 2020, 10255, p. 874.

⁵ R. Horton, *Offline: a global health crisis? No, something far worse*, “The Lancet”, 395, 2020, 10234, p. 1410.

seeing the world, a discourse, which is closely linked (not surprisingly) to mainstream bio-medical science. We need to get inside that way of seeing the world to understand not just some interesting philosophical issues, but also to help to do things better. We think this will also lead to a more policy-friendly approach. We aim to show that epidemiology rests on very specific epistemic assumptions which determine what is (and is not) regarded as admissible knowledge, evidence and proof. These assumptions sideline a population or social perspective proper, reducing them to background and context, rather than part of the explanatory and actionable process. We claim that epidemiology is an *individual-level* science, despite the widespread claims to be population level. We will explain this thoroughly below, but our position is that epidemiology makes measurements of health and disease in *individuals*, and then aggregates them into populations⁶. This may seem an odd, not to say eccentric, statement given the work of Geoffrey Rose⁷. He distinguished between the causes of a case (individual level), and the causes of incidence (the changes in numbers of cases – population or social level). Notwithstanding the seminal position of Rose's work, and the importance of his distinction between the individual risk and population risk, our contention is that the thinking in epidemiology remains locked into an individual-level epistemology. Therefore, and despite the huge knowledge base produced in social epidemiology, we still miss informative and tractable accounts of complex relational interactions and *mixed mechanisms* between the individual and the social and between the biological and social sphere.

The paper is organized as follows. In section 2, we reconstruct the historical development of public health interventions, leading to epidemiology becoming its main evidence base. In section 3, we explain that this evidence base is, contrary to a widespread claim, an aggregate of individual-level observations, thus neglecting the proper population or social dimension of health and disease. This is not to criticize epidemiology, but it is to identify a fertile terrain for exploring the synergies between epidemiology and social science approaches to health and disease – this exploration we undertake in section 4, and we exemplify the potential positive impact on public health interventions in the case of the COVID-19 pandemic.

⁶ M.P. Kelly, *The individual and the social level in public health*, in *Evidence based public health: Effectiveness and efficiency*, A. Killoran, M.P. Kelly (eds.), Oxford University Press, Oxford 2009, pp. 425-435.

⁷ G. Rose, *The strategy of preventive medicine*, Oxford University Press, Oxford 1992; *Sick individuals and sick populations*, "International Journal of Epidemiology", 30, 2001, 3, pp. 427-432.

2. *A brief historical reconstruction of the evidence base of public health interventions*

Public health is an interdisciplinary field tasked with the design and implementation of interventions, the goal of which is to prevent and reduce the burden of disease, protect and improve health and to reduce health inequalities in populations⁸. Public health interventions may target specific biological processes or behavioural, social, commercial and industrial factors, playing a role in the development and spreading of disease. They may target a population as whole, or specific subgroups, or individuals. The design process of public health interventions does not always follow strict protocols and it may vary depending on the norms of the institutions in charge in different countries. Yet, while there is no single protocol for the design, it is fair to say that the main evidence base of public health interventions is generated by research done in epidemiology. Epidemiology is considered the main generator of the evidence base of public health interventions. It is usually defined as the study of variations in health and disease within and across populations⁹. The field is organized in numerous subfields, focusing on specific aspects of the health and disease, for instance clinical epidemiology, social epidemiology, epidemiology of occupational health, and its most recent addition, i.e. molecular epidemiology.

Public health interventions take many forms, and an historical lens is revealing of the way things have evolved. From the mid-fourteenth century, public health interventions involved efforts to control infections, such as Bubonic Plague (the Black Death). The only option available to authorities over millennia were measures of isolation, quarantine, and various efforts at social control¹⁰. The idea of contagion is very old, with ref-

⁸ R.S. Bhopal, *Concepts of epidemiology: Integrating the ideas, theories, principles, and methods of epidemiology*, Oxford University Press, New York 2016; R.C. Brownson, *Evidence-based public health*, Oxford University Press, Oxford-New York 2003; R.J. Donaldson, *Essential community medicine including relevant social services*, Springer Science & Business Media, 1983; S. Griffiths, D.J. Hunter, *New perspectives in public health*, Radcliff Medical Press, Abindon 2017.

⁹ R.C. Brownson, *Evidence-based public health*, cit.; R.J. Donaldson, *Essential community...*, cit.; S.A. Valles, *Philosophy of population health science*, cit.

¹⁰ P.E. Pormann, *The mirror of health: discovering medicine in the golden age of Islam*, Royal College of Physicians, London 2013; P.E. Pormann (ed.), *"Epidemics" in context: Greek commentaries on Hippocrates in the Arabic tradition*, De Gruyter, Berlin 2012; S. Halliday, *The great stink of London: Sir Joseph Bazalgette and the cleansing of the Victorian metropolis*, History Press, New York 2013; M. Susser, Z. Stein, *Eras in epidemiology: the evolution of ideas*, Oxford University Press, Oxford-New York 2009; S. Johnson, *The ghost map: the story of London's most terrifying*

erences in Greek mythology and the Bible. Over time, protective measures changed little. Foucault's account of French responses to epidemics in the seventeenth and eighteenth centuries is interesting because he describes two things happening: first, the control of state (and church) on people's everyday lives, and, second schisms and controversies within the medical profession over different understandings of the disease¹¹. The part of the medical profession which gained the upper hand was the one that allied itself with the state, as the state took for itself the right to interfere in the private sphere of people's lives¹².

Infection had been a part of the human condition since time immemorial, but industrialization and urbanization in the nineteenth century seems to have greatly highlighted the problem, forever crystalizing the idea of the patterning of disease with deprivation and poverty¹³. Cholera, typhus, typhoid, scarlet fever, diphtheria, tuberculosis, and influenza killed millions of people and infected many others; it is only by the end of the 19th century, with the eventual understanding of the role of microbes in infection, as well as with improvements in nutrition and general living conditions, that the tide of infectious disease seemed to ebb¹⁴. Antibiotics, vaccination, improvements in maternal and child health, maternity services and screening programs also provided tools allowing public health to make significant inroads on the profile of disease by the time we reach the 1950¹⁵.

What is sometimes called an 'epidemiological transition' is said to have occurred after the mid-20th century with the gradual diminishing number of deaths from infectious disease (in the Western World) and the gradual increase in the numbers of deaths from non-communicable diseases linked to cigarette smoking, alcohol intake, calorie consumption and physical inactivity¹⁶. The simple notion of an epidemiological transition is

epidemic – and how it changed science, cities, and the modern world, 2008; A. Kessel, *Air, the environment and public health*, Cambridge University Press, Cambridge-New York 2006.

¹¹ M. Foucault, *The birth of the clinic*, Taylor & Francis, London 1973.

¹² L. McCray Beier, *For their own good: the transformation of English working-class health culture, 1880-1970*, Ohio State University Press, Columbus 2008; A.F. La Berge, *Mission and method: the early nineteenth-century French public health movement*, Cambridge University Press, Cambridge-New York 2002.

¹³ W.T. Gairdner, *Public health in relation to air and water*, Edmonston & Douglas, Edinburgh 1862.

¹⁴ T. McKeown, *The role of medicine: Dream, mirage, or nemesis?*, Princeton University Press, Princeton 2014.

¹⁵ L. McCray Beier, *For their own good*, cit.

¹⁶ A.R. Omran, *The epidemiologic transition: a theory of the epidemiology of population change*. 1971, "The Milbank quarterly", 83, 2005, 4, pp. 731-757.

now seen as a gross oversimplification; infectious diseases never went away even in advanced societies, and in developing societies they remained endemic, and famine likewise¹⁷. Moreover, the simple distinction between infectious and diseases of lifestyle is not itself scientifically robust, as the ‘syndemic’ approach suggests¹⁸. However, the findings of early epidemiological studies associating disease with social behaviour and social and economic conditions, remain fundamentally important. Even if there was no epidemiological transition strictly speaking, there was most certainly an epistemological consolidation. The really important epidemiological investigations by Doll and Hill into the causes of lung cancer and other diseases with exposures to cigarette smoking and industrial toxins was a watershed scientifically¹⁹. Pinpointing particular toxins, like cigarette smoke, allowed for a new way of tackling certain diseases which were all about the identification of risk factors, often linked to behaviour and what is sometimes called lifestyle²⁰.

There were two elements in the epistemological consolidation. First, those public health reformers who linked disease to social conditions in the 19th century – Chadwick, Snow, Villermé – set out an approach to public health which was social in orientation²¹. Their foci, in various ways, were on social and industrial life and its health damaging consequences. In the European and North American contexts for example, the targets for intervention were frequently local municipalities, slum clearance, housing and sanitation. However, the star of the social approach faded towards the end of the century, with the various discoveries of Pas-

¹⁷ A.J. Mercer, *Updating the epidemiological transition model*, “Epidemiology and Infection”, 146, 2018, 6, pp. 680-687; A. Mercer, *Infections, chronic disease, and the epidemiological transition: a new perspective*, University of Rochester Press, Rochester 2014; M. Vaughan, K. Adjaye-Gbewonyo, M. Mika (eds.), *Epidemiological change and chronic disease in sub-saharan Africa: social and historical perspectives*, UCL Press, London 2021.

¹⁸ M. Singer, *Introduction to syndemics: a critical systems approach to public and community health*, Jossey-Bass, San Francisco 2013; M. Singer *et al.*, *Syndemics and the biosocial conception of health*, “The Lancet”, 389, 2017, 10072, pp. 941-950.

¹⁹ R. Doll, *Mortality from lung cancer in asbestos workers*, “British Journal of Industrial Medicine”, 1955, 12, pp. 81-86; R. Doll, A.B. Hill, *Smoking and carcinoma of the lung*, “BMJ”, 2, 1950, 4682, pp. 739-748; R. Doll, A.B. Hill, *Study of the aetiology of carcinoma of the lung*, “BMJ”, 2, 1952, 4797, pp. 1271-1286; R. Doll, A.B. Hill, *Mortality in relation to smoking: Ten years’ observations of British doctors*, “BMJ”, 1, 1964, 5396, pp. 1460-1467.

²⁰ T.R. Dawber, W.B. Kannel, *The Framingham study: An epidemiological approach to coronary heart disease*, “Circulation”, 34, 1966, 4, pp. 553-555; P.A. Sytkowski *et al.*, *Sex and time trends in cardiovascular disease incidence and mortality: The Framingham heart study, 1950-1989*, “American Journal of Epidemiology”, 143, 1996, 4, pp. 338-350.

²¹ S.W.P. Chave, *John Snow. The broad street pump and after*, “The Medical Officer 99”, 1958, pp. 347-349.

teur, Lister and Koch and specifically of germs and microbes. The demonstrable efficaciousness of protecting people from bacteria by providing clean water and good sanitation, as well as the ability to target the microbes in various ways, shifted the focus down from the social to the individual. Second, the work of Doll and Hill and the identification of cigarette smoke and asbestos as causes of disease to all intents and purposes treats the toxins like microbes. Toxins precede pathology just like viruses and bacteria, and reducing people's exposure has proved effective. The focus has been on the individual, quintessentially with remonstrations to stop smoking as the most effective way to avoid (individual) exposure to cigarette smoke. All the various risk factors which have since been identified for non-communicable disease likewise find their principal vector in the individual's behaviour, while they should *also* be located at the level of their social environment²².

During the 20th century, therefore, epidemiology has brought to light some of the most important medical discoveries the application of which has had enormous benefits to the health of the population. The understanding of the origins of many diseases owes a huge amount to epidemiological investigation. The role of cigarette smoking in lung cancer and heart disease, the discovery of the role of diet, exercise and alcohol consumption in early mortality and the dementias, the unravelling the pathways to infection in HIV and AIDS as well as earlier observations about diseases with their origins in industrial toxins like asbestos, lead and phosphorus, and more generally the links between poverty, deprivation and disadvantage and ill health and early death, all owe a large debt to epidemiological science. The epistemological consolidation is complete, with epidemiology the handmaiden of this shift. But this very success has helped to conceal some important problems, as we explain next.

3. Epidemiology as science of health and disease of individuals

Despite the widespread claim that epidemiology is a population science, we contend that it is in fact a science of the individual, but at an *aggregate* level: it adds up all the individual cases and, in this way, it manages to create a solid evidence base about health and disease in populations, meant as aggregates of individuals. However, epidemiology does not conduct its analysis at the level of population or of society, in the sense of so-

²² P.A. Sytkowski *et al.*, *Sex and time trends*, cit.

cial groups with proper and distinct social dynamics, which would constitute a level of explanation and analysis in its own right. It is in this sense that we claim that epidemiology remains largely individual and non-relational. The dynamic and relational interaction between human agency and social structure, and the emergent social practices in which people engage, is almost entirely invisible in the epidemiological paradigm, while it has been described in detail in sociology²³.

This is all the more true in the era of *molecular* epidemiology²⁴. Molecular epidemiology is in fact the latest frontier in the field of epidemiology. It tries to understand the development of disease as part of a broader understanding of exposure: we are exposed to hazards, outside our bodies, but then this exposure continues inside the body too; it is the *total* exposure that we need to study in order to understand disease onset and development²⁵. A molecular approach to exposure will help understand – at the biological and biochemical level – exactly how exposure works. This approach has given us invaluable understanding about the onset and development of health and disease, and yet, there have been controversies about its legitimate place within epidemiology. To begin with, in the first days of molecular epidemiology, some raised the concern that shifting the unit investigation down to the molecular level, effectively meant betraying the inherent principles of epidemiology, namely to study individuals not populations. The danger, as we see it, is that shifting the unit of analysis down at the molecular level paves the way to reductionist accounts of health and disease. As the field has advanced and managed to

²³ P. Bourdieu, *Pascalian meditations*, Stanford University Press, Stanford 2000; Id., *The logic of practice*, Stanford University Press, Stanford 2008; A. Giddens, *Central problems in social theory: action, structure, and contradiction in social analysis*, University of California Press, Berkeley 1979; A. Giddens, F.R. Dallmayr, *Profiles and critiques in social theory*, University of California Press, Berkeley 1982; A. Giddens, *The constitution of society: outline of the theory of structuration*, University of California Press, Berkeley 1986.

²⁴ F.P. Perera, I.B. Weinstein, *Molecular epidemiology and carcinogen-DNA adduct detection: New approaches to studies of human cancer causation*, "Journal of Chronic Diseases", 35, 1982, 7, pp. 581-600; E.J. Radford, *Exploring the extent and scope of epigenetic inheritance*, "Nature Reviews Endocrinology", 14, 2018, 6, pp. 345-355; P.A. Schulte, F.P. Perera, *Molecular epidemiology: Principles and practices*, Elsevier Science, Saint Louis 2012.

²⁵ G.M. Slavich, S.W. Cole, *The emerging field of human social genomics*, "Clinical Psychological Science", 1, 2013, 3, pp. 331-348; G.M. Slavich, M.R. Irwin, *From stress to inflammation and major depressive disorder: A social signal transduction theory of depression*, "Psychological Bulletin", 140, 2014, 3, pp. 774-815; C.P. Wild, *Complementing the genome with an "exposome": The outstanding challenge of environmental exposure measurement in molecular epidemiology*, "Cancer Epidemiology Biomarkers & Prevention", 14, 2005, 8, pp. 1847-1850; C. Wild, S. Garte, P. Vineis, *Molecular epidemiology of chronic diseases*, Wiley, Hoboken 2013.

generate groundbreaking, new knowledge, the problem of the unit of analysis has arisen again. In fact, no matter how well we understand the biology and bio-chemistry of health and disease, from a public health perspective, molecules and biomarkers are hardly ‘actionable’. The next challenge of molecular epidemiology is therefore to climb up the ladder again and relate the biology and bio-chemistry to the social dimension of health and disease. It is in fact at this level we can find actionable factors.

To be sure, this is a direction taken in the latest projects in molecular epidemiology, for instance *Lifepath* (<https://www.lifepathproject.eu>), in which biochemical knowledge about health and disease is studied and contextualized in a life-course approach. A life-course approach, in turn, is not only open to, but essentially includes information about socio-economic factors through the whole life of individuals²⁶. In this approach, specifically, recent attempts to understand the ‘social to biological transition’, or how social environments may act on the biology, investigate, for instance, the mechanisms of epigenetics and the role of allostatic load²⁷. Notwithstanding the importance, relevance, and timeliness of this line of research, the ‘social’ is studied for its possible causal effect on the ‘biological’, but there are in fact many other relations that would be of relevance: from the biological to the social, and any other path in between and across (i) individual level and group level, and (ii) social, psychological, political, cultural factors and the biological factors proper. Thus it would be important to study, for instance, how certain medical conditions influence one’s life, and depending on the different socio-economic environment one lives in, or the different health infrastructure one has access to.

The contribution of epidemiology to establishing important evidence base for public health has been great well before epidemiology became more ‘experimental’ and oriented towards the biochemistry of health and

²⁶ M. Kelly-Irving, S. Tophoven, D. Blane, *Life course research: new opportunities for establishing social and biological plausibility*, “International Journal of Public Health”, 60, 2015, 6, pp. 629-635; A. Sacker *et al.*, *Never too early, never too late: social and biological influences on health and disease over the lifecourse*, 2016.

²⁷ R. Castagné *et al.*, *Allostatic load and subsequent all-cause mortality: which biological markers drive the relationship? Findings from a UK birth cohort*, “European journal of epidemiology”, 33, 2018, 5, pp. 441-458; D. Blane *et al.*, *Social-biological transitions: how does the social become biological?*, “Longitudinal and Life Course Studies; Vol. 4, No. 2, 2013: Longitudinal and Life Course Studies; M. Lock, *Comprehending the body in the era of the epigenome*, “Current Anthropology”, 56, 2015, 2, pp. 151-177; M. Meloni, *The social brain meets the reactive genome: neuroscience, epigenetics and the new social biology*, “Frontiers in Human Neuroscience”, 8, 2014.

disease. In fact, its proper observational method, as exemplified by the Bradford Hill guidelines²⁸ and through the analysis of evidence as is done in institutions such as NICE or IARC, are exemplars of solid scientific method, despite regular attacks on it as being ‘junk science’²⁹. Our line of argument is *not* that epidemiology is junk science. Instead, we aim to shed light on how the largest evidence base for public health interventions is about the biochemistry of health and disease and about *individual* factors of many kinds. Defenders of epidemiology will rebut and argue that social epidemiologists *do* study the role of social factors. But these defences actually miss the point: the study of social factors still happens at the individual level, which is then aggregated into populations.

It is in this sense that we claim that a main epistemic value at work in epidemiology is the reliance on the ‘individual’ as the unit of analysis. We think that *more* is needed: detailing the *mixed mechanisms* of health and disease that happen not only across social and biological factors, but also in the relational social dynamics across individuals and groups. Below we will illustrate how we think this populational and social perspective can be added to epidemiology. But before we proceed, let us turn to COVID-19 as the latest prominent case in which the individual is at the centre of the analysis and of many interventions that have been put in place.

The global response to COVID-19 has been twofold. First, to prevent the spread of infection and second to develop vaccines. This is logical and, in the circumstances, the best and probably only options initially available. Progress on vaccines has been encouraging. However, efforts to enforce social restrictions to prevent spread, markedly less so. Those jurisdictions which experienced SARs in the early part of the twenty first century were very swift to institute very strict, to total lockdowns, involving major limitations of civil liberties. In the UK, most of Europe, and North and Latin America, such action was much less restrictive. Speed was clearly important, but in varying ways the restrictions in the Global West have not been sufficient to curb infections quickly. If measures can be introduced which effectively stop the spread, then since the virus needs a continuous series of human bodies to infect in order to survive, without that chain, it would be contained. There has been much

²⁸ A.B. Hill, *The environment and disease: Association or causation?*, “Proceedings of the Royal Society of Medicine”, 58, 1965, 5, pp. 295-300.

²⁹ P. Boffetta *et al.*, *False-positive results in cancer epidemiology: A plea for epistemological modesty*, “JNCI: Journal of the National Cancer Institute”, 100, 2008, 14, pp. 988-995; P. Vineis, *Viewpoint: The skeptical epidemiologist*, “International Journal of Epidemiology”, 38, 2009, 3, pp. 675-677.

criticism of governmental action in the West in this regard. But this is not our argument.

For us, the more important point relates to those members of the community who were most prone to serious infection and to dying from the virus. There was a clear association between social factors and disease severity and risk of death. Early on, the data made clear that the most vulnerable to serious infection and mortality from COVID-19 were the socially disadvantaged, black and minority ethnic groups, men, certain occupational groups (mostly those involving close contact with the public and many of which are low paid and low skilled) and the elderly³⁰. Another important early finding was that those who suffered the most severe infections were likely to already have a preceding medical condition, such as type 2 diabetes, coronary heart disease, obesity, and dementia. As early as 2003, there were already papers in the peer reviewed literature highlighting the interaction between these conditions and coronaviruses³¹. The two biological pathologies – the pre-existing disease and the virus – interact with each other, to greatly exacerbate the disease process. The data also show that there is a third party involved in the interaction – social position and specifically social disadvantage. The epidemiology has been particularly good at describing the virus' pathological associations with existing disease³², and the biological processes are readily hypothesized³³.

However, the nature of the interaction with the third dimension – the social – while clear in the associational data, remains undescribed in explicit mechanistic or causal terms, as instead suggested by advocates of evidential pluralism³⁴. The nature of the three-way interaction, the connection between the biological and the social remains a significant gap in the evidence. This is an important research area, we would contend, and one that, in the event of a future pandemic, we ought to be ready for. It

³⁰ M.G. Marmot *et al.*, *Build back fairer: The COVID-19 Marmot review. The pandemic, socioeconomic and health inequalities in England*, 2020.

³¹ M. Singer, *Introduction to Syndemics: A Critical Systems Approach to Public and Community Health*, Jossey-Bass, San Francisco 2009.

³² M.G. Marmot *et al.*, *Build back fairer*, cit.

³³ K. Suzuki, *The developing world of DOHaD*, "Journal of Developmental Origins of Health and Disease", 9, 2018, 3, pp. 266-269.

³⁴ M.P. Kelly, F. Russo, *Causal narratives in public health: the difference between mechanisms of aetiology and mechanisms of prevention in non-communicable diseases*, "Sociology of Health & Illness", 2017; V.-P. Parkkinen *et al.*, *Evaluating evidence of mechanisms in medicine: Principles and procedures*, Springer International Publishing, Cham 2018; F. Russo, *Public health policy, evidence, and causation: lessons from the studies on obesity*, "Medicine, Health Care and Philosophy", 15, 2012, 2, pp. 141-151.

requires a full elaboration of the mixed mechanisms at work, socially and individually. In practical terms, special measures to protect the especially vulnerable and susceptible *could* have been employed, but in fact they were not. Instead, the potentially most vulnerable were mostly the ones who had to continue to work as drivers, carers, warehouse operatives, as well as front line nursing and medical staff. The latter of course are not normally thought of as socially disadvantaged (though many front-line care staff are among the lowest paid), but nevertheless they were subject to greater exposure.

If we reflect on why the third social element is absent, other than in associational terms, the answer, we suggest, is that the social operates in a different epistemic frame. It is about relationships between individuals and groups, it is about what they do and how they spend their time, it operates in different epistemological universe to epidemiology, with its focus on the individual in biomedicine. It is not uncommon to find the social being articulated in medical investigations, but it is seldom foregrounded and usually plays a role as context, or in epidemiology variables like age, gender, occupation are used to test for confounding. There is in other words an epistemic divide.

This is an old problem. The pioneers of public health reform in the nineteenth century, such as Gairdner, Snow, Duncan and Villermé, had a very clear understanding that the social environments in which people lived profoundly influenced the individual cases as well as the patterns of disease, which they observed. They didn't know how it worked. And arguably we still don't, at least with enough precision to intervene effectively. Amongst other things, contemporary epigenetics and metabolomics underpins an urgent need to explore these mechanisms, and not just in the case of COVID-19. Contemporarily, there are competing explanations of the biological pathways explaining epigenetic and metabolomic actions. The broad argument however – that there is a clear and mechanistic pathway from social exposures to biological manifestations in the body – is not in doubt, but what it actually consists of *is* in doubt. Just imagine if in this pandemic these mixed mechanistic pathways had been known, or even hypothesized, how much better public health interventions might have been.

4. *What else does (social) epidemiology need?*

Our argument so far is *not* that epidemiology has not studied social factors and socio-economic determinants of health. Quite the contrary:

social epidemiology has done a stunning job in documenting that socio-economic determinants are correlated with different health outcomes and with health inequalities. Some key references will suffice to establish the relevance and importance of this field³⁵. Our point is that, despite social epidemiology being part of knowledge base of public health interventions, arguably, (i) social factors are not really targeted in far too many interventions and (ii), we still lack the ‘why’ of the well-established correlations of social epidemiology.

We contend that the root cause of these two shortcomings lies in the individual-level epistemology of (social) epidemiology described in section 3. What (social) epidemiology does not provide is information about group dynamics, contexts, behaviour and social practices, which can be very local, or very specific to particular groups. It is there, implicitly in much of the work, but it remains obscured by a dominant epistemic viewpoint.

One may rebut that this is exactly what medical sociology studies, and in great detail: this field has extensively explored how socio-economic structures influence the concept of disease, or how power structures interfere in the (good) delivery of health services etc.³⁶ But medical sociology is part of the evidence base of public health intervention only to a limited degree. This is in part because the social dynamics described and studied in medical sociology are often not about the *mixed mechanisms* of health and disease, in which *both* social and biological factors play a role, and that we think would be the key to improve significantly on the knowledge base of public health.

Thus, for instance, over and above collecting statistics about COVID-19 infections and deaths per age group, we need a lot more information about the key social mechanisms *and* thick descriptions of the dynamic and relational conditions in which the virus spread. What kind of social practices and material conditions facilitate infection in different home and working conditions? Or in schools? Or in places of worship? Or in households with very different age groups? Why can we allow up to X number of people per square meter in a bus but Y in a shop? Detail-

³⁵ M. Bartley, *Health inequality: an introduction to concepts, theories and methods*, Polity, Malden 2017; C. Bambra, *Health divides: where you live can kill you*, Policy Press, Bristol-Chicago 2016; M. Marmot, *Social determinants of health inequalities*, “The Lancet”, 365, 2005, 9464, pp. 1099-1104; M. Marmot, *Fair society, healthy lives: Strategic review of health inequalities in England post 2010*, 2010.

³⁶ E. Annandale, *The sociology of health and medicine: a critical introduction*, Polity, Malden 2014.

ing the socio-biological mechanisms at work in different contexts will help immensely with designing tailor-made preventive measures for different social groups, and also to effectively communicate to the public. But this requires an important shift in the values driving research, re-habilitating qualitative and small-scale social science research to enrich the knowledge base of public health.

The description of the mixed mechanisms of health and disease is however not an easy task. *Methodologically*, this would require integrating standard, quantitative-oriented social epidemiology approaches with qualitative, small-scale studies in social science³⁷. *Conceptually*, this would require adopting the notion of ‘mixed mechanism’. This means (i) that mechanisms are not reduced / reduceable to biology, (ii) that social factors are *causal* factors on par with biological ones, and (iii) that social and biological factors interact in some way to be detailed and described. Relatedly, this also means adopting a broader view on causation, in which we allow causal relation to happen across levels (individual-group) and across different types of factors (biological-social)³⁸.

A different methodological and conceptual approach is needed because public health interventions are more likely to succeed when tailored to specific groups, contexts, or environments. Many measures did not have enough policy traction during the pandemic because they were too vague and high level, instead of being local. We also think that the rationale behind local and tailored interventions should take advantage of a clearer and more effective science of communication, hopefully increasing compliance with safer conduct.

For instance, as we mentioned earlier, a general lockdown aims at reducing infection rates in the overall population, but does not actually protect the most vulnerable groups, taking advantage of specific social dynamics proper to these groups. Selected closure of e.g. pubs and restaurants is instead targeting specific groups of the population, where infection risk may not have been uniformly very great. The reason to forbid gatherings after say 6pm is not that the virus is more infectious in the evening, but because *specific social dynamics* happen at that time of the

³⁷ F. Russo, M.P. Kelly, *The ‘lifeworld’ of health and disease and the design of public health interventions*, 2020.

³⁸ P. Illari, F. Russo, *Information channels and biomarkers of disease*, “Topoi”, 35, 2016, 1, pp. 175-190; M.P. Kelly, R.S. Kelly, F. Russo, *The integration of social, behavioral, and biological mechanisms in models of pathogenesis*, “Perspectives in Biology and Medicine”, 57, 2014, 3, pp. 308-328; M.P. Kelly, F. Russo, *Causal narratives in public health...*, cit.; F. Russo, M.P. Kelly, *The ‘lifeworld’ of health and disease...*, cit.

day and within specific groups. And the choice to close some places (e.g. pubs) rather than others (e.g. schools) does not necessarily have a scientific base (only), but is also a question of priorities at the ethical level and/or of social values. The tailoring of public health measures to contain a pandemic such as COVID-19 would have had a better chance if we had more detailed understanding of the mixed mechanisms of health and disease, because these would contain many more actionable factors, tailored to specific environments, groups and their dynamics.

5. Conclusion

COVID-19 is the severest public health crisis of the 21st Century thus far. The pandemic has (yet again) shown us how much we are vulnerable, despite the very advanced level of our best bio-medical and epidemiological knowledge. Isolating the virus did not take that long. But the spread of infection is not just a matter of biology – it is also, if not foremost, a matter of dynamic and relational social practices and behaviours.

Reflecting on the knowledge base of public health measures against COVID-19 helps us restate our arguments even more forcefully. Public health interventions have better chance of success if the social factors are analysed properly. Work in this direction exists³⁹, and we should further contribute to it by complementing the individual-level epistemology of (social) epidemiology with population-level epistemology that describes social dynamics as part of the knowledge base of public health interventions.

³⁹ N.M. Kriznik *et al.*, *Moving beyond individual choice in policies to reduce health inequalities: The integration of dynamic with individual explanations*, “Journal of Public Health”, 40, 2018, 4, pp. 764-775.

Political epistemology of pandemic management

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Abstract: Today, claims about the contiguity of health management and societal organization bring biopolitical concerns to the forefront. This essay offers historical-political insights on the COVID-19 pandemic, which are particularly urgent, as both the temporal and the cultural-political dimensions have been insufficiently considered in current debates. After introducing our specific political-epistemological approach, we delve into the entanglements of medical expertise, economic interests, surveillance politics, and diplomatic relations in the past in order to shed light on the present. Additionally, we address the limitations of Italian theory's *biopolitica*, namely its idle radicalization of critical views on medical politics inspired by French *épistémologie historique*. We conclude with a call to scientists' responsibility in consideration of the societal embedment of their activity. Yet, the task of an emancipated science is not only in their hands but depends on our collective capacity to organically connect their work to the renewal of the body politics at large.

Keywords: pandemics, biopolitics, political epistemology, history of epidemics

1. Introduction

History-writing is a political act, as we look at the past not only to understand our present but also to change the future¹. In times of global pandemics, medical history takes on an unprecedented relevance, while Foucauldian claims about the contiguity of health management and modern societal organization bring biopolitical concerns to the forefront (Fig.

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¹ Cf. A. Gramsci, *Quaderni del carcere*, Einaudi, Turin 2007, Notebook 10 §2, pp. 1241-1242.

1)². In this essay, we offer historical-political insights on the COVID-19 pandemics, which we see as particularly urgent. Even if there is a lot of historical discussion on biopolitics, a more nuanced political epistemology approach remains to be written³. We first introduce our group's political-epistemological approach; we then discuss the entanglements of medical expertise exerted through quarantine, economic interests and surveillance politics in the past in order to shed light on the present conjuncture; third, we address the limitations of Italian theory's *biopolitica*, namely its idle radicalization of critical views on medical politics inspired by French *épistémologie historique*⁴. We conclude with a reappraisal of the view (which is less and less reflected upon) that science is not neutral and scientists and scientific institutions carry a responsibility for the societal consequences of their activity⁵. However, the task of imagining and realizing

² See also P.D. Omodeo, *Review-Interview with Roger Cooter. The Critical Intellectual in the Age of Neoliberal Hegemony*, "Journal for the Interdisciplinary History of Ideas", IV, 7, 2015, pp. 1-5, p. 20; G. Isabelle, *COVID-19 et capitalisme: le triomphe de la biopolitique?*, "Contretemps. Revue de Critique Communiste", 2 November 2020, retrieved from: <https://www.contretemps.eu/coronavirus-capitalisme-biopolitique-foucault-agamben-esposito-marxisme/>; D. Lorenzini, *Biopolitics in the Time of Coronavirus*, "Critical Inquiry", 2021, 47, S2; L. van den Berge, *Biopolitics and the Coronavirus*, "Netherlands Journal of Legal Philosophy", 2020, 1, pp. 3-6.

³ Cf. P.D. Omodeo, *Political Epistemology: The Problem of Ideology in Science Studies*, Springer, Dordrecht 2019.

⁴ Epistemology and history of science have interpenetrated each other in the French cultural context. Debates about the process of canonizing *épistémologie historique* as a research tradition are still open today. Traditionally, this term refers at least to the triad composed of Gaston Bachelard, Georges Canguilhem and Michel Foucault (see D. Lecourt, *Pour une critique de l'épistémologie: Bachelard, Canguilhem, Foucault*, Maspero, Paris 1972; J-F. Braunstein, *Bachelard, Canguilhem, Foucault. Le «style français» en épistémologie*, in P. Wagner, *Les philosophes et la science*, Gallimard, Paris 2002). The concept of biopolitics covers an essential role for several authors of French *épistémologie historique*. Biopolitics is crystallized in Foucault's work (starting from *The Will to Knowledge*), but it is also found in Georges Canguilhem's reflections (especially *Writings on Medicine*). If in Foucault and Canguilhem, biology has an individual role and an independent field of research within the biopolitical paradigm, this is not true for Agamben and Esposito's biopolitics. Here, biology is used as a tool to provide an ontological explanation of life. For Canguilhem and Foucault, biology and medicine are practices of social problematization and their philosophy is linked to the concept of "life." On the contrary, Agamben and Esposito's biopolitics loses contact with the living pushing it into a metaphysical domain, no longer vital.

⁵ On the non-neutrality of science, see J-M. Lévy-Leblond, A. Jaubert, (*Auto*)*Critique de La Science*, Éditions du Seuil, Paris 1973; G. Ciccotti et al., *L'ape e l'architetto. Paradigmi scientifici e materialismo storico*, FrancoAngeli, Milano 2011; H. Rose, S. Rose, *The Radicalisation of Science: Ideology of / in the Natural Sciences* Macmillan, London 1976; S. Harding, *The Science Question in Feminism*, Cornell University Press, Ithaca-London 1986; B. Barnes, *Scientific Knowledge and Sociological Theory*, Routledge & Kegan Paul, London 1974; D. Bloor, *Knowledge and Social Imagery*, University of Chicago Press, Chicago 1976; B. Barnes, D. Bloor, J. Henry, *Scientific Knowledge. A Sociological Analysis*, Athlone, London 1996; cf. G. Ienna, *Fisici italiani negli anni '70. Fra scienza e ideologia*, "Physis" (forthcoming).

a science for an emancipated society is not only in their hands but depends on our collective capacity to organically connect our work to the renewal of the body politic at large.

2. *Methodological overture: political epistemology*

We would like to preliminarily stress the political dimension of science and of all reflection and discourses on it, especially the academically established meta-sciences (the history and philosophy of science, the sociology of science, and the anthropology of science). The ‘political’ concerns the three main questions of historical epistemology, of the roots of science, its validity and functions (i.e., the implicit and explicit goals and the connected praxis).

Science is the social activity par excellence⁶. As the pioneer of historical epistemology, Ludwig Fleck stressed in *Genesis and Development of a Scientific Fact* (1935), knowledge is inherently collective⁷. He stressed the shared character of scientific and medical knowledge, which is always determined by historically transmitted styles of thought (*Denkstile*)⁸. They reflect the societal conditions out of which the sciences and their facts emerge. Prescriptive elements, ethical and even mythical ones, are part of the development of science in all of its stages, including the present, and they guide future research as an ineliminable ideological factor. Fleck regarded the case of syphilis as paradigmatic. Throughout the centuries, Europeans looked at this venereal disease with great concern, owing to its sexual connotation and the perception as a divine scourge for sexual sins. Thus, its importance was social in the first place. Fleck compares syphilis with other contagious diseases that received lesser attention from public health administrators, scientists and the population in general. For instance, tuberculosis received a different ethical connotation, as a sort of ‘Romantic disease’ and as such was a lesser motivation for state-funded medical research although it caused more casualties than syphilis. “No head of public health search would be able to arouse enthusiasm in the

⁶ L. Fleck, *Genesis and Development of a Scientific Fact*, University of Chicago Press, Chicago 1979, p. 42.

⁷ The interpretation of Fleck as a historical epistemologist is well established. See, among others, H-J. Rheinberger, *Historische Epistemologie zur Einführung*, Hamburg 2007, and F.O. Engler, J. Renn, *Gespaltene Vernunft: Vom Ende eines Dialogs zwischen Wissenschaft und Philosophie*, Berlin 2018, esp. Chap. 8 and 9.

⁸ L. Fleck, *Genesis and Development of a Scientific Fact*, cit., pp. 125-145.

nation's best research workers, because it is a socially unimportant disease"⁹.

Drawing on Fleck's insights that science is a collective, ethically connotated and politically driven activity, we direct our political-epistemological approach to the critical inquiry of the political entanglements of science and medicine, including at the meta-level of disciplinary discourses on science, especially the academically established meta-sciences (the history and philosophy of science, the sociology of science, and the anthropology of science) in a time in which debates about facts and their assessment have become of paramount relevance in public debates and political decision making (from climate change to health management). In our view, the 'political' concerns the three main questions of historical epistemology, of the roots of science (or the 'genesis'), its validity, and its functions (i.e., the implicit and explicit goals and the connected praxis). We should consider these three questions one after the other.

Concerning the roots of science, the question relates to both the cognitive and the historical origin of science. They do not have to be thought separately, as the social processes of abstraction that took place under concrete historical circumstances and in connection with specific needs (geometry from measurement, arithmetic from computation, more abstract mathematical practices from symbolic practices, etc.) have to be constantly interiorized by learning individuals through experiences of cognitive appropriation and reactivation of mental structures¹⁰. The political meaning of a social reconstruction of the history of science was clear to the pioneers of the sociological approach in history of science in the twentieth century, Boris Hessen, Henryk Grossmann, Edgar Zilsel and, of course, Fleck, who reaffirmed the collectivist character of knowledge as an important measure against elitist attitudes that were widely accepted by scientists, as was reflected in the widespread cult of 'pure science', the scientific genius and the merely 'internalist' comprehension of the history of scientific ideas¹¹. Fleck specifically attacked the 'dogmatism' of speculative epistemology (*epistemologia imaginabilis*) that 'analytically' reduces cognition to a relation between knowing subject and the known object without taking into account the necessary mediation of cul-

⁹ Ivi, p. 77.

¹⁰ P. Damerow, *Abstraction and Representation: Essays on the Cultural Evolution of Thinking*, Springer, Dordrecht 1995.

¹¹ B. Hessen, H. Grossmann, *The Social and Economic Roots of the Scientific Revolution* (eds.), G. Freudenthal, P. McLaughlin, Springer, Dordrecht 2009; E. Zilsel, *The Social Origins of Modern Science* (eds.), D.W. Raven, W. Krohn, R.S. Cohen, Kluwer, Dordrecht 2003.

ture¹². Today's studies on 'practical knowledge' are the heirs of those perspectives although the political awareness has often been diluted, perhaps owing to a sense of more widespread tolerance towards bottom-up politics and forms of knowledge¹³.

The second historical-epistemological question concerns validity, the problem of method and, more abstractly, the determination of truth criteria¹⁴. The political implications of such a problem were not always clear to the champions of modern mathematical science, such as Galileo, those who integrated it with a philosophical reflection on method – prototypically, Descartes – and those who investigated the rational constituents of science – most importantly, Immanuel Kant's subjective *a priori* of knowledge. Yet, neither the practice nor the methods nor the structuring factors of scientific knowledge have ever been given in absolute terms but evolve historically and are tightly connected with epistemic and non-epistemic values. At moments, the political emerged in the philosophical conceptions of the 'epistemological century' of the first reception of Descartes, for instance in Hobbes' "political epistemology"¹⁵. The latter materialist thinker expressed not only the knowledge-power entwinement but also sensed the political meaning of the usage of reason and the theory of knowledge in his various polemical fronts – against the pluralist empiricism of the Royal Society just as against the theo-politics of 'conventionalism' à la Bellarmine¹⁶.

The awareness of the historicity of the *a priori* of science and the stronger objectivity that positioned knowledge can achieve have emerged in the wake of the Marxist critique of political economy, neo-Kantian philosophies of science and radical science movements in the twentieth century. The question of the values and interests that are embedded in science and its truth criteria is still of impelling actuality in an age that is marked by the uncritical (re)emergence of neo-positivist attitudes, novel forms of social Darwinism, scientist reductionism (even scientist superstition), and technocracy. The fundamental enlightenment question arises:

¹² L. Fleck, *Genesis and Development of a Scientific Fact*, cit., p. 50.

¹³ P. Smith, *The body of the artisan: Art and experience in the Scientific Revolution*, The University of Chicago Press, Chicago 2004.

¹⁴ D. Bloor, *Knowledge and Social Imagery*; Joseph Rouse, *Knowledge and Power. Toward a Political Philosophy of Science*, Cornell University Press, Ithaca-London 1987.

¹⁵ S. Shapin, S. Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, Princeton University Press, Princeton 2011 (1985), p. 99.

¹⁶ G. Freudenthal, *Atom and Individual in the Age of Newton. On the Genesis of the Mechanistic World View*, D. Reidel Publishing Company, Dordrecht 1986.

how can we secure a *rational* use of *scientific rationality*? This is the political crux of the *question de la méthode*.

Thirdly, as far as the functions of science are concerned, they relate both to the materiality of science as a force of societal production and reproduction, as well as to its cultural function. Bacon's vision of science as a means to master nature has become an indisputable reality in the industrial age of science as a productive force. In his classic studies on the function of science, Bernal pointed to the two-sidedness of science, as its goals and uses can serve progressive politics of emancipation as well as destruction, the capitalist exploitation of nature and humanity, even fascism¹⁷. The latter connections motivated the Frankfurt denunciation of the Enlightenment dialectics that transformed science and reason from a means of human mastery of nature into a means of control and dominion of humans. "The mastery over the mastery of nature"¹⁸ can be turned into an instrument of despotism instead of freedom. Hence the necessity of a political and not only technical assessment of science, its results and goals arise.

This is particularly pressing in view of the cultural function of science as an instrument of ideology, that is, as a means of construction of consensus over the status quo and justification of the societal reality. Such reactionary and depersonalizing function occurs whenever solutions are advanced, which transform political problems into technical ones¹⁹. Hence, a science-democracy dilemma emerges often in connection with the most urgent problems of the present such as health and the environment: Who is in charge of decisions? The experts or the people? And, connected to this, the problem of scientific education, not to be confused with popularization²⁰. The emergence of such problems is also intrinsically related to the social division of labour and the establishment of a form of bureaucratization characteristic of the modern state and capitalist economy²¹.

Technology has always been at the centre of material and political reflections on science. In fact, technology constitutes a juncture between

¹⁷ J.D. Bernal, *Social Function of Science*, Routledge, London 1946 (1939), pp. 1-11, 155-159, 210-231.

¹⁸ A. Schmidt, *The Concept of Nature in Marx*, Verso, London 1962, pp. 12-13.

¹⁹ J. Habermas, *Toward a Rational Society, Student Protest, Science, and Politics*, Beacon Press, Boston 1989 (1969), pp. 102-103.

²⁰ H. Collins, R. Evans, *The Third Wave of Science Studies: Studies of Expertise and Experience*, "Social Studies of Science", XXXII, 2, 2002, pp. 235-296; A.I. Goldman, *Experts: Which Ones Should You Trust?*, "Philosophy and Phenomenological Research", 63, 1, 2001, pp. 85-110.

²¹ M. Weber, *Economy and Society. An Outline of Interpretive Sociology*, University of California Press, Berkeley 1978, pp. 956-1005.

the intellectual realm of the universalizing abstraction of science, on the one hand, and the material realm of practice, production, economy and, of course, politics²². Social historians of science and materialist epistemologists have long pointed to the relevance of technology as the basis for modern science: according to the so-called Hessen-Grossmann thesis, modern mechanics resulted from the codification of machine technology and know-how, which, in turn, was fuelled by the material and economic interests of expanding profit economy²³.

Moreover, technology has been thematized – perhaps more metaphorically – in connection with the study of organizational techniques and governmental problems. As Boltanski and Chiapello have shown, an essential element of the establishment of the most recent phases of the spirit of capitalism is manifested through the emergence of management as a mixed form of technical organization of the social division of labour and moral prescriptions²⁴. The birth of Taylor's scientific management immediately raised educational and moral concerns about the psycho-physical amount of repression that was necessary to create the 'factory gorilla', the worker of the assembly line realized by Ford in the first decades of the twentieth century. Antonio Gramsci's reflections on "Americanism and Fordism" in his *Prison Notebook* n. 22 are exemplary of early cultural-political critiques of scientific management (which are consonant with Marx's position on the workers' alienation in the Paris manuscripts and later discussions on 'reification' from Lukács to the Frankfurt School)²⁵. The post-'68 phase has been characterized by total reabsorption of the social criticisms that emerged during '68 in the mesh of capitalist ideology (for example, replacing the values of stability and security typical of Fordism with those of mobility, autonomy and personal self-realization). The ideological and social function of management is to generate a form of knowledge capable of producing ethical-technical prescriptions in the social organization of labour capable of preserving capitalism through a constant neutralization of forms of criticism²⁶.

²² "Socio-Political Coordinates of Early-Modern Mechanics: A Preliminary Discussion", in R. Feldhay, J. Renn, M. Schemmel, M. Valleriani (eds.), *Emergence and Expansion of Preclassical Mechanics*, Springer, Cham 2018, pp. 55-78.

²³ B. Hessen, H. Grossmann, *The Social and Economic Roots*, cit., pp. 1-40.

²⁴ L. Boltanski, È. Chiapello, *The New Spirit of Capitalism*, Verso, London 2007, p. 58.

²⁵ A. Gramsci, *Quaderni Dal Carcere*, Einaudi, Turin 1975 (1948), pp. 2139-2181; A. Feenberg, *The Philosophy of Praxis: Marx, Lukács, and the Frankfurt School*, Verso, London 2014.

²⁶ L. Boltanski, È. Chiapello, *The New Spirit of Capitalism*, cit., pp. 57-102.

With the spread of forms of technocratic management of politics, it seems to us, therefore, that in contemporary societies the science of business management is also spreading to the organizational structure of the policies of the nation-states. From this viewpoint, in the context of the advanced capitalist society, science and technology assume the role of a concrete productive force²⁷. All this has effects on the forms of governmentality and the processes of subjectification that it implies. Foucault has brought to our attention what he calls the “technologies of the self”, the social techniques of sexual education and repression which are at the basis of the construction of subjectivities, as well as techniques of bodily manipulation and biological regulation of society²⁸. The latter problem, the problem of biopolitics, is closely connected, in Foucault’s view, to the modern forms of societal control²⁹.

3. *A historical-critical perspective: entanglements of medicine, technical expertise and society*

Following Fleck’s suggestion to aim for an analysis of science conceived as a mundane activity shaped by political, cultural and economic factors, in this section we examine the historical development of quarantine. Similar to what happens today with social distancing and quarantine to slow down the COVID-19 pandemic, the history of quarantine shows its administrative use through which multifaceted interests of political powers, nation-states, health institutions and affected people converged in modern forms of social and sanitary control.

The quarantine, maybe one of the oldest administrative measures to counter the plague and other infectious diseases that humans have experienced, was ideated between 1384 and 1465, when the sanitary council of Venice, the most important commercial port that exchanged cargos with the Levant, and the nearby Republic of Ragusa (today Dubrovnik) established the isolation of infected ships for forty days³⁰. In the manage-

²⁷ G. Ciccotti *et al.*, *L'ape e l'architetto*, cit., pp. 92-93.

²⁸ M. Foucault, *La technique de soi*, in Id., *Dits et Écrits 1980-1988*, IV, cit., pp. 783-813; Id., *La technologie politique des individus*, in *Dits et écrits*, IV, cit., pp. 813-828.

²⁹ M. Foucault, *La naissance de la médecine sociale*, in Id., *Dits et écrits 1976-1979*, III, Gallimard, Paris 1994, pp. 207-228; Id., *Society Must Be Defended. Lectures at the Collège de France, 1975-76*, Picador, London 2005; Id., *The Birth of Biopolitics: Lectures at the Collège de France, 1978-79*, Palgrave Macmillan, New York 2008.

³⁰ W. Hardy McNeill, *Plagues and Peoples*, Anchor Books, New York 1976.

ment of epidemics, quarantine was a means to counter outbreaks by isolating individuals and communities. The Lazzaretto of Venice was created about six hundred years ago, in 1423, as an island-hospital for the confinement of all those who contracted the plague. The close-by island of S. Lazzaro was the place in which individuals with leprosy had been long detained in a sort of ghost city of deformed and sick people ruled by clerks. Within a few decades, in 1468, a third island, today known as Lazzaretto Nuovo, was deputed to serve as a place of hope for those who could be transferred to this next station for their convalescence³¹. The new Lazzaretto was deputed to quarantine those 'suspected' to be infected or who had been in contact with sick people, as well. Moreover, it became a place for the quarantine of vessels, goods and people who entered the lagoon from countries affected by contagious ills. A *magistrato alla sanità* (health magistrate) was instituted after the plague of 1485 and its extensive and dramatic spread, which kept track of the movements of people, watched over the poor and prostitutes, as it was assumed that people circulation, misery and sexuality favoured the spreading of disease. Moreover, this institution developed an intelligence network in order to collect information about diseases in other countries. Such information could be used for commercial battles and international politics, too. For instance, when, in the fifteenth century, the Republic of Ragusa quarantined ships from Venice, as the plague was taking over the city, Venice later responded by blocking ships from Ragusa in retaliation. Quarantine was therefore the main means to address epidemics as well as a means of war that went along the making of European states.

The commerce managed by the Dutch with the East and West Indies caused, in 1663, the appearance of the plague in the Netherlands. By 1664 the plague killed over 35,000 people in Amsterdam. England, Sweden and Denmark, which competed with the Netherlands for the access to Levant and Asia markets, imposed an extremely long and sometimes unjustified quarantine on Dutch vessels³². By analysing the plague epidemic that took place in Marseille in 1720, French historian Jean-Pierre Papon highlighted the role of the merchants who decided when to end the administrative measures of lockdown and sanitation³³, to eventually

³¹ N.E. Vanzan Marchini, *Rotte mediterranee e baluardi di salute*, Skira, Geneva-Milan 2004, pp. 17-45.

³² M. Harrison, *Contagion: How Commerce Has Spread Disease*, Yale University Press, New Haven 2005, p. 25.

³³ J.-P. Papon, *De la Peste, ou Epoques Mémorables de ce Fléau, et Les Moyens de s'en Préserver*, I, Lavilette et Compagnie, Paris 1800, p. 340.

suggest that since the functioning of health boards is challenged by particular interests, it would be advisable to avoid a committee entirely composed by merchants³⁴.

During the fifteenth and nineteenth centuries, trade began to play such a key role that the most important commercial ports of the Mediterranean Sea, following the Venice model, equipped themselves with health boards and sanitary institutions to quarantine ships, goods and crews in lazarettos. Quarantine was born and extensively used as an administrative measure to save the trade of European powers, and their wealthiest population from the contagion spread across maritime trade routes. The cholera pandemic of 1817 was the first of six cholera outbreaks between 1817 and 1917³⁵. It exploded in British India and spread through Russia, China, and the Middle East, across to West Africa. In India alone, it is estimated that one to two million people died. The disease created and aggravated social issues.

In Russia, the poor protested quarantine restrictions that hindered their ability to work and survive. In 1831, a popular revolt against the quarantine burst out in the Russian Tambov administrative area. The bloody repression caused 2,300 deaths, as troops stationed in the area until 1833 to quash the uprisings³⁶. By 1832, during the second cholera pandemic of the nineteenth century, the disease had travelled across Russia to Western Europe and England, and had reached the Americas causing a significant impact on political systems and economies³⁷.

Gradually, scientific advancements offered a better understanding of cholera. In 1849, physician John Snow hypothesized that the cholera outbreak had microbial origins. He also inferred that microbes spread via the sewage system by leaking into the aqueducts' clean drinking water. In 1854, Italian microscopist Filippo Pacini identified the microscopic *Vibrio* responsible for what was then called Asiatic cholera³⁸. He realized

³⁴ Ivi, II, p. 142.

³⁵ D.P. Fidler, *The globalization of public health: the first 100 years of international health diplomacy*, "Bulletin of the World Health Organization", 79, 2001, pp. 842-849; N. Howard-Jones, *The Scientific Background of the International Sanitary Conferences, 1851-1938*, *History of International Public Health*, 1, 1975; V. Huber, *The unification of the globe by disease? The international sanitary conferences on cholera, 1851-1894*, "The Historical Journal", 49/2, 2006, pp. 453-476.

³⁶ R.E. McGrew, *The First Cholera Epidemic and Social History*, "Bulletin of the History of Medicine", 34/1, 1960, pp. 61-73.

³⁷ F. D'Abramo, S. Neumeyer, *A historical and political epistemology of microbes*, "Centaurus", 62/2, 2020, pp. 321-330.

³⁸ F. Pacini, *Osservazioni microscopiche e deduzioni patologiche sul cholera asiatico*, Tipografia Federico Bencini, Firenze 1854.

that the contagion needed an “organic living substance” in order to be able to cause, reproduce, and spread the disease³⁹. During the second half of nineteenth-century contagion, the idea that a disease spread through contact or proximity among individuals, was countered at least by two subjects: liberal politicians, who despite the dramatic effects of the cholera pandemics wanted to keep international trade going on, as well as by all those who wanted to counter the symbolic, oppressive power of quarantine, often used by officials and governments to segregate the minorities⁴⁰. Before the scientific discoveries of Pacini, Snow, Pasteur and Koch, European medical institutions that countered the theory of contagion and the related practices such as the quarantine, represented a notable number. After the scientific observations that confirmed the presence of living, transmissible entities causing the spread of disease, the anticontagionists suddenly declined, and in a few decades sanitary institutions started to develop their interventions based on new kinds of diagnostics and therapeutics tested the African people of European colonies⁴¹.

Between 1851 and 1938, a series of fourteen conferences known as the International Sanitary Conferences took place across Europe, and the United States. Each country was represented by a diplomat and a physician. The goal was to standardize international quarantine regulations and negotiate preventive measures which eventually affected not only health policies, but reformed national economies and destabilized political systems⁴². Moreover, the misuse of quarantine undertaken during the previous centuries as a means of “foreign policy” and “weapon of war” was recognized, in the nineteenth century, as an issue to solve through so-called health diplomacy⁴³. Therefore, the emergence of international sanitary coordination lies, in part, in the misuse of maritime quarantine with the deliberate and consequent disruption of commerce and the anger of merchants and their political allies. When the problems caused by epidemics, and the improper use of quarantine added to the 1831 Egyptian invasion of the Ottoman province of Syria, which posed a direct threat to

³⁹ Ivi, p. 27.

⁴⁰ E. Heinz Ackerknecht, *Anticontagionism between 1821 and 1867*, “Bulletin of the History of Medicine”, 22/5, 1948, pp. 562-593.

⁴¹ See M. Lock, Vinh-Kim Nguyen, *An Anthropology of Biomedicine*, Hoboken, New Jersey 2018, pp. 79-102, and E. Bonhomme, *When Africa was a German laboratory*, “Al Jazeera”, 6/11/2020, <https://www.aljazeera.com/opinions/2020/10/6/when-africa-was-a-german-laboratory>

⁴² S.J. Watts, *Epidemics and History: Disease, Power, and Imperialism*, Yale University Press, New Haven 1999; M. Harrison, *Contagion: How Commerce Has Spread Disease*, Yale University Press, New Haven 2013.

⁴³ M. Harrison, *Contagion: How Commerce Has Spread Disease*, cit., p. 277.

British and French commerce, the European powers played the new diplomatic card.

Interestingly, the convenors of the first sanitary conferences refuted the theory of contagion and indicated the quarantine as a waste of time⁴⁴. The anticontagionist stance prevented both national and colonial administrators of Great Britain from recognizing vibrio cholera leaking from the sewers in aqueducts and irrigation canals as the main cause of epidemics, to instead attributing the main cause of the cholera epidemics to the unhygienic habits of the Indian people and in so doing avoided tackling the material and logistic aspects of a structural reform of aqueducts and irrigation canals⁴⁵. A similar procrastination of infrastructural reforms needed to halt the cholera outbreak regarded also London, where the fragmentation and antagonism of administrative and economic powers managing the city waters, delayed the implementation of Pacini and Snow's theories⁴⁶.

Thus, nineteenth-century health diplomacy often considered health issues caused by epidemics as a function of the most influential powers' commercial interests. This power relation translated into discrimination concerning alleged European exceptionalism versus the social, political and medical conditions of Asian and Muslim countries⁴⁷. At the 1874 Vienna conference, the travelers departing from India, the epicentre of the cholera epidemic, were obliged to undertake quarantine in Asia. Similarly, Muslim and Arab pilgrims were indicated as more susceptible to contagion than European people, and therefore in need of being quarantined in their home countries, while European powers liberalized the use of quarantine across European states. These sanitary, administrative buffer zones, to prevent an alleged passage of disease from the Orient, have been implemented through an international telegraph-based reporting system of contagion disease⁴⁸, which was considered jointly by the delegates of

⁴⁴ N. Howard-Jones, *The Scientific Background of the International Sanitary Conferences, 1851-1938*, World Health Organization, Geneva 1975.

⁴⁵ S.J. Watts, *Epidemics and History: Disease, Power, and Imperialism*, cit., pp. 167-212.

⁴⁶ C. Hamlin, *Politics and germ theories in Victorian Britain: The Metropolitan Water Commissions of 1867-9 and 1892-3*, in R. MacLeod (ed.), *Government and Expertise: Specialists, Administrators and Professionals, 1860-1919*, Cambridge University Press, Cambridge 2003, pp. 110-127.

⁴⁷ V. Huber, *The Unification of the Globe by Disease? The International Sanitary Conferences on Cholera, 1851-1894*, "The Historical Journal", 49/2, 2006, pp. 453-476.

⁴⁸ The reporting system of contagious diseases ideated within the nineteenth-century international sanitary conferences was the forerunner of the global epidemiological surveillance system used by the World Health Organization. Cf. F. D'Abramo, *The past and present of pandem-*

the 1893 Dresden conference, and applied in Europe after the 1894 Paris conference⁴⁹.

Several international health organizations were established before the First World War but only after the end of the war, in 1922, the League of Nations was formed as the world's first intergovernmental organization with its own Health Committee and Health Section⁵⁰. In 1948, the WHO was established as one of the earliest specialized agencies of the United Nations. The WHO presents itself as technical and apolitical: an organization that welcomes membership universally. Accordingly, staff members are considered, "international civil servants", with no national responsibilities, and no national attachments, and a special focus of the organization is on epidemic diseases⁵¹.

During the Cold War, the WHO suffered from tensions between the United States and the socialist countries. For instance, during the first years of the WHO, countries of Eastern Europe such as Poland, Yugoslavia and Czechoslovakia were blocked by the Americans from developing their own production of penicillin. When in 1949 Josef Plojhar, Czechoslovak health minister and Roman Catholic priest asked at the World Health Assembly why the Americans did not deliver the remaining machines bought by the Czechoslovak government to start their penicillin production, and referring explicitly to the contract signed by both the parties, the American delegate answered: "Contract, no contract, you turned socialist, you get nothing!"⁵². As shown by historian Dora Vargha, the American delegate Leonard Andrew Scheele referred to the diplomatic clash and dismissed the protests by stating that the equipment in question was not necessary for the production of penicillin. After about two years from the inception of the WHO in 1948, one by one, Albania, Bulgaria, Romania, Hungary, Czechoslovakia, and Poland left the international agency. And mainly because of the lack of access to scientific discoveries.

ic management: health diplomacy, international epidemiological surveillance, and COVID-19, "History and Philosophy of the Life Sciences", 2021, <https://doi.org/10.1007/s40656-021-00416-4>.

⁴⁹ Howard-Harrison, *The Scientific Background of the International Sanitary Conferences*, cit.

⁵⁰ I. Borowy, *Coming to Terms with World Health: The League of Nations Health Organization 1921-1946*, Peter Lang, Bern 2009.

⁵¹ J. Farley, *Brock Chisbalm, the World Health Organization, and the Cold War*, UBC Press, Vancouver 2009.

⁵² D. Vargha, *Technical Assistance and Socialist International Health: Hungary, the WHO and the Korean War*, "History and Technology", (2020-forthcoming).

Given that the WHO is the result of strong diplomatic negotiations, it is far from being just an apolitical and technical organization. Within the WHO the most influential member states push for their own interests and mobilize their diplomatic channels within the organization to achieve their goals⁵³. The discourses and practices of lockdown and quarantine undertaken during the COVID-19 pandemic follow the trajectories of social actors and political powers that have been trying to cope with the spread of epidemics for centuries⁵⁴. These epistemologies, especially those of the modern liberal phase, contain conflicting and contradictory elements that need to be analysed at the historical, social, political and economic levels so as to pave the way for emancipatory conceptions and uses of biomedical sciences.

4. *Politics of life, the dead-end of 'biopolitica'*

The politics of life has gathered momentum in recent years, after Michel Foucault proposed looking at the quarantine methods developed in modernity as a path towards modern forms of government. The sciences, in particular biomedicine play a central role⁵⁵. Foucault uses the plague pandemic to demonstrate how modern forms of government have developed. In early modernity, sick people simply had to be separated from the healthy, and the plague was faced through the activation of a complex control system on sick individuals (like the Venetian one). If the leper was simply excluded and recognized as sick from the neighbourhood without any real public interference, the plague that spread rapidly had to be controlled in a centralized manner. Hence, the development of the ideal of an omniscient power, symbolized by the Panopticon. It was a circular prison, developed in more recent times, in which a single guard was able to watch over all the prisoners who, conversely, could not see him. This acted as a surveillance model that shows well what Foucault understands as the transition from disciplinary power to biopolitical power.

⁵³ M. Cueto, T.M. Brown, E. Fee, *The World Health Organization. A History*, Cambridge University Press, Cambridge 2019.

⁵⁴ An epistemological and political analysis of the biology-society interplay of the current pandemic, is offered by S. de Chadarevian, R. Raffaetà, *COVID-19: Rethinking the nature of viruses*, "History and Philosophy of Life Science", 43/2, 2021, <https://link.springer.com/article/10.1007/s40656-020-00361-8>

⁵⁵ M. Foucault, *La naissance de la médecine sociale*, cit., Eng. tr., *Birth of Social Medicine*, in J. Faubion (ed.), *Power: Essential Works of Foucault*, III, New Press, New York 1984, pp. 134-156.

The Panopticon symbolizes the potential of the power to perpetually control without this being manifest. In the modern age, to keep the plague under control, power constitutes an organization of social surveillance, implemented through spatial partitioning, family control, inspections and registration systems. This is a “branching out of power” that sections every moment of life to be controlled⁵⁶. While leprosy could be managed by a bi-dimensional regime (healthy vs. sick and exiled, inside vs. outside the community), the plague required a multiplicity of application points of power and therefore a new organization that was developed on countless fronts. The crucial part of the new biopolitical power is positivity: power no longer denies through rules and prohibitions, but it seeks to invest the entire vital area by potentiating and managing it⁵⁷. Firstly, power does not consider the single individual but the collectivity (a new concept of population emerges) and, secondly, the individual is no longer considered juridically but biologically: life must be organized and guaranteed through a process of medicalisation that involves as many aspects of the subject’s life as possible. Thus, power creates as it were “a regime of truth”: it sets up a system of meaning in which identities (e.g., race, sex, illness) take on a new value and guarantee a political, economic and moral connection. Eventually, power is structured through application to the subject: power works only if it leverages a subject that amplifies it and makes it emerge from its practices⁵⁸. The new concepts that were extraneous just before are thus assimilated, produced and reproduced ‘from below’ and become part of life permeating a certain social order making the subject dependent on this new sense⁵⁹.

Moving now to the theoretical dimension of these notions – not pandemics per se but the reflection on the ‘management of life’ itself – we turn to the problematic notion of biopolitics, which has returned to the fore in recent times due to...the current pandemic. Biopolitics is a slippery and contested term, first coined by Foucault in lectures at the Collège de France in the 1970s⁶⁰ and given new ‘life’ in a more irrational-

⁵⁶ Today this control is moved to a digital domain, through Apps, data tracking, positioning, drones, satellite images.

⁵⁷ M. Foucault, *La volonté de savoir*, Gallimard, Paris 1976, pp. 120-125.

⁵⁸ M. Foucault, *Naissance de la biopolitique*, Gallimard, Paris 2004, pp. 40-47.

⁵⁹ An example is the practice of social distancing today.

⁶⁰ There is a difference, as we briefly discuss, between ‘biopower’ and ‘biopolitics’; the terms first appear in Foucault’s *Histoire de la sexualité*, I (*La volonté de savoir*), Gallimard, Paris 1976. The topic of power in Foucault was the object of a scholarly and theoretical industry all by itself. In the context of reflecting on biopolitics in 2020/2021, suffice it to say that Foucault

ist (and public) usage by Italian philosopher Giorgio Agamben and other thinkers in his circle in recent years⁶¹. The peculiarity of Foucault's vision lies in its consideration of the basic biological characteristics of life as a site of resistance. There is no simple reduction to a totally biological 'naked life' incapable of subjectification, in which the only possible resistance is negation and estrangement. On the contrary, biopower applies to a subject and it is only in and through that subject that it works, hence a total nullification of subjectivity is never possible. There is always a point of resistance, the living being, that can positively oppose biopower. This concept of resistance is the point where the different interpretations given by 'Italian biopolitics' and by Foucault diverge⁶².

Part of the difficulty with the term 'biopolitics' is that it is both descriptive and prescriptive, or empirical and normative: that is, it describes a state of affairs – in fact, different possible states of affairs – in which governments 'rule over life'. The existence of public health bureaucracies, but also the management of various medical conditions, and the emergence of biotech, as a research and investment area but also, again, a top-down, government-mandated area, are all cases of 'biopolitics' in the simpler, descriptive sense. Less immediately relevant in the current situation, but also crucial in the contemporary biopolitical arena, is the idea of 'biocapital'⁶³. For instance, someone with a rare genetic disorder can be useful to drug companies; the human body can now be viewed in profit-making terms⁶⁴.

The more prescriptive or normative sense of biopolitics comes in when a thinker denounces the State for 'disciplinary power over the body', something that has come into sad and vivid focus with the current pandemic, but which is by no means new. This can range from the 'management' of refugees to the confinement of populations viewed as literally contagious.

Foucault and Agamben have two different approaches to biopower. For Foucault, it is a way that a particular sovereign power develops in

doesn't either hypostatize the concept of power or create a negative theology of it (as Agamben does). See Foucault's lecture, *Les mailles du pouvoir*, in *Dits et écrits*, IV, cit., pp. 182-201; and the works on this topic by Maurizio Lazzarato.

⁶¹ See R. Esposito, *Immunitas. The Protection and Negation of Life*, Polity, Cambridge 2011.

⁶² D. Gentili, *Italian Theory. Dall'operaismo alla biopolitica*, Il Mulino, Bologna 2012.

⁶³ See K. Sunder Rajan, *Biocapital. The Constitution of Postgenomic Life*, Duke University Press, Durham 2006, which presents an ethnographic and economic analysis of genomics (in the U.S. and India).

⁶⁴ See R. Skloot, *The Immortal Life of Henrietta Lacks*, Random House, New York 2010.

modernity⁶⁵, while for Agamben it is a constant in the civilized world (from the ancient Greeks onwards)⁶⁶: “Western politics is a biopolitics from the very beginning”⁶⁷. The concept of life must not be read, according to Italian biopolitics, in the light of history-finding in the subject a point of discontinuity where we can find resistance and production like in Foucault - but on the contrary, life must be conceived as ‘naked’ and resistance gives way to negation. According to Agamben and Esposito, life can resist power only if it is de-historicized and de-subjectivized⁶⁸ and they conceive the *dispositif* and the struggle in transcendental terms that cannot be found in Foucault.

In this shift towards prescriptive biopolitics, all of society becomes defined in terms of inner and outer:

The decisive fact is that, together with the process by which the exception everywhere becomes the rule, the realm of bare life – which is originally situated at the margins of the political order – gradually begins to coincide with the political realm, and exclusion and inclusion, outside and inside, bios and zoe, de jure and *de facto*, enter into a zone of irreducible indistinction.⁶⁹

Throughout his work and public editorials at least since the 1990s, Agamben has used the *Lager* concept in a generalized, ahistorical way, in his Auschwitz book, with the ‘ontology’ provided in *Homo sacer*⁷⁰. Back in 2002, he wrote a widely translated editorial in newspapers arguing that the projected Constitution for the EU was like Auschwitz (total control over life); fast forward to early March 2020 and he says the same thing about confinement in a time of COVID-19⁷¹.

⁶⁵ P. Rabinow, N. Rose, *Biopower Today*, “BioSocieties”, 1, 2006, pp. 195-217.

⁶⁶ G. Agamben, *Homo Sacer: Sovereign Power and Bare Life*, Stanford University Press, Stanford 1998, pp. 2-4; see also K. Genel, *The Question of Biopower: Foucault and Agamben*, “Rethinking Marxism”, 18, 2006, pp. 44-48.

⁶⁷ G. Agamben, *Homo Sacer: Sovereign Power and Bare Life*, cit., p. 181.

⁶⁸ D. Gentili, *Italian Theory. Dall'operaismo alla biopolitica*, cit., pp. 10-15.

⁶⁹ G. Agamben, *Homo Sacer: Sovereign Power and Bare Life*, cit., p. 9 (translation modified by the authors).

⁷⁰ See N. Rose, *The Politics of Life Itself*, “Theory Culture & Society”, 18/1, 2001, p. 3; and Id., *The Politics of Life Itself. Biomedicine, Power and Subjectivity in the Twenty-First Century*, Princeton University Press, Princeton 2007. For an excellent critique of the category of ‘camp’ in Agamben, see B. Aspe, M. Combes, *Retour sur le camp comme paradigme biopolitique*, “Multitudes”, 1/1, 2000, pp. 29-44. <https://doi.org/10.3917/mult.001.0029>.

⁷¹ We note that aside from historical or theoretical disagreements with Agamben, one can also say, as Negri did and as Foucault probably would have if he had been alive, that the ‘bare life’ rhetoric deprives agents of agency. Luca Paltrinieri uses the example of refugees in refugee centres. See L. Paltrinieri, *Between (Bio)Ethics and (Bio)Politics: What Life?*, Beistegui & Gra-

It is clear that ever since *Homo sapiens* first appeared, there have been apparatuses; but we could say that today there is not even a single instant in which the life of individuals is not modeled, contaminated, or controlled by some apparatus⁷².

One can comment, to borrow a phrase from Catherine Mills, that the supposed politics of life in Agamben is in fact a politics of death – not *biopolitics*, but *thanatopolitics*⁷³.

Foucault's reflections on biopower and biopolitics are also closely connected to reflections on the emergence of modern liberalism. In that context, he makes a point which is a good antidote against the Agambenian focus on a kind of Kafkaesque or fascistic State figure: that bio-forms of power are not just about the 'sovereign' or the head of state; the boss of a big biotech firm also has biopower, as we are experiencing right now again of course (vaccines), and countries like the U.S. are perpetually trapped in discussions of health insurance and the price of remedies⁷⁴.

Similarly, Nikolas Rose pointed out, contra Agamben, but back in 2007, that our form of control now is not social or collective but individual (sculpting ourselves into the desired individual – "from normalization to customization")⁷⁵. In a much more subtle way than Agamben, closer to Foucault's historically and socially precise analyses, Rose speaks of the "democratization of biopolitics"⁷⁶. Rather than the dark figure of eugenics, Rose emphasizes the ways in which "genetics was to transform itself into a liberal discipline"⁷⁷ – although of course in 2020 the interplay between genetic therapies and State interventions returns in a time of pandemic. Indeed, recent events move our individual biotechnological self-transformation a bit into the background (unless we imagine a cyborg im-

ciouse (eds.), *The Care of Life: Transdisciplinary Perspectives in Bioethics and Biopolitics*, Rowman & Littlefield International, Lanham 2014.

⁷² G. Agamben, *What is an apparatus?*, Stanford University Press, Stanford 2009, p. 15.

⁷³ C. Mills, *Biopolitics*, Routledge, London 2018, p. 44. See also A. Mbembe, *Necropolitics*, "Public Culture", 15/1, 2003, pp. 11-40.

⁷⁴ The management of the COVID-19 emergency in northern Italy, and in particular in Lombardy, demonstrated how private health care had taken the place of public health care and how regional decisions on prevention were assigned to the managers of nursing homes and private hospitals. The result of this was, at the beginning of the 2020s, a complete disintegration of the network of regional healthcare that led to the inability of public healthcare to respond to the demands of citizens, who were instead redirected towards private healthcare.

⁷⁵ N. Rose, *The Politics of Life Itself. Biomedicine, Power and Subjectivity in the Twenty-First Century*, cit., p. 20. Rose also reflects on the idea of 'biological citizenship', *ivi*, p. 223.

⁷⁶ *Ivi*, p. 17.

⁷⁷ *Ivi*, p. 12.

mune to viruses that the super-rich could turn themselves into), and indeed social control, object of Agamben's obsession, into the foreground.

With respect to the background of biopolitical thinking in the tradition of 'historical epistemology', it is worth noting that not just Foucault, but his mentor Georges Canguilhem, had provided instruments for analysing the interplay between the biological and social that are more subtle than Agamben *et al.*'s messianic ones. In a paper on the notion of "regulations" in the organism and in society⁷⁸, Canguilhem tries to demonstrate how the biological characterization of the living being doesn't mean that the living being's subjectivity must be considered from the biological point of view. In that sense, he does not flatten life into a biological form. To be clear, it is not that Agamben or his school reduce human life to a kind of reductionist biology (or socio-biology), something they would view in the utmost hostile terms. Rather, they reduce the human faced with the biopolitical violence of the State to a kind of victimized, humiliated, tortured body, the paradigm of which is, again, the dehumanized individual of the camps. Agamben and thinkers close to him like Roberto Esposito are perfect instances for our time of what Theodor Adorno called, referring to Heidegger, the "jargon of authenticity"⁷⁹ – a kind of disempowering mystical language of unmediated experience that eliminates agency or critique. Once this kind of discourse seizes on the pandemic, it either produces transcendentalized discourses of the State as a kind of biopolitical monster, or symmetrically complementary portrayals of victimhood without agency. That these biopolitical critiques present themselves as *political* is an irony⁸⁰ nicely visually captured in the singular piece of bad taste, the cover of the collective volume *Sopa de Wuhan*, that appeared in Argentina in the early Spring of 2020 (at the

⁷⁸ G. Canguilhem, *Le problème des régulations dans l'organisme et dans la société*, in "Cahiers de l'Alliance Israélite universelle", 92, 1955, reprinted in Canguilhem, *Oeuvres Complètes: Résistance, philosophie biologique et histoire des sciences 1940-1965*, IV, Vrin, Paris 2015, pp. 643-72. Canguilhem wrote several other papers on the topic in later years.

⁷⁹ T. Adorno, *The Jargon of Authenticity*, Routledge, London and New York 1973. Worse, sometimes there is a kind of fascination with violence in these writings (Agamben was a great reader of Benjamin's essay "Critique of Violence", and of course of Carl Schmitt who was in the background for Benjamin): the deliberate lack of argument at times 'naturalizes' violence, as one feels when reading Esposito's *Immunitas* (perhaps not incidentally related to René Girard).

⁸⁰ The contributions of Agamben, Esposito, Žižek, Nancy, although quite different from each other, are all part of what we would define as contemporary biopolitical theory. Political epistemology offers an alternative to Biopolitics to analyze the Covid pandemic situation. In this paper, we do not intend to suggest a new positive Biopolitics, but we try to use the concepts used in Biopolitics differently.

height of the first wave of the pandemic), with the names of Agamben, Žižek and other luminaries on the cover) (Fig. 2)⁸¹.

We conclude this brief analysis of the aporias of biopolitics with Walter Benjamin's words, in his essay *Critique of Violence*, which have ironically been quoted by Agamben and others in his circle:

It might be well worthwhile to track down the origin of the dogma of the sacredness of life. Perhaps, indeed probably, it is relatively recent, the last mistaken attempt of the weakened Western tradition to seek the saint it has lost in cosmological impenetrability.⁸²

Benjamin's words are not unambiguous, and can indeed be taken in a more 'Enlightenment' direction – as stating a kind of blunt reality of secularization, that different myths are gradually emptied out of their meaning, 'life' being perhaps the last one – or a more 'counter-Enlightenment' direction – turning back, as Agamben would, to a kind of *Abgrund* of ineffable experience. On our part, we find support for a de-transcendentalized, historicized, Enlightenment understanding of biopolitics in Benjamin's words.

5. Conclusion: political economy of disease and the science of tomorrow

As far as biopolitics are concerned, we see the political dimension of the politics of life and vice versa the biologization of politics as crucial problems. We need to address both for a correct understanding of the link between today's science, technology and society, a link that is by necessity historical, economic, and political. Pandemic management is an exemplary case to inquiry into political epistemology, which we understand as a sustained reflection on science that brings together the history of science (including the sociology of science), the philosophy of science and political theory. As much as we acknowledge the relevance of biopolitics as a debate that has opened up fundamental questions, we are critical

⁸¹ For a more sympathetic, and interesting discussion of Esposito (and Rose) see R. Cooter and C. Stein, *Cracking Biopower*, "History of the Human Sciences", 23/2, 2010, pp. 109-128. See also C. Wolfe, *Review of Davide Tarizzo, "Life: A Modern Invention"*, in "Notre Dame Philosophical Reviews" (<https://ndpr.nd.edu/news/life-a-modern-invention/>) (accessed on 12 December 2020).

⁸² W. Benjamin, *Critique of Violence*, in *Selected Writings: 1913-1926*, Harvard University Press, Cambridge 1996, p. 251.

of its transformation into a *doctrine*, a set of answers and theories, especially political ones. Such a trend is specifically evidenced by in the so-called ‘Italian theory’ of the main proponent of this label, Roberto Esposito, in whose perspective the political (at times even metaphysical) interests have obliterated the crucial relevance of medical and technological issues although these were at the roots of Foucault’s inquiries⁸³. This loss of contact with the historical and biomedical reality is creating a gulf between biopolitical political theory and the historical-philosophical reflection of medicine. In our view, this constitutes a fundamental mistake as it misleadingly hypostasizes scientific practices and theories and makes any understanding of the connection of science and society impossible. Abstract biopolitics can eventually lead to forms of self-referentiality by philosophers, who consider political uses and abuses of biomedicine to be the main tools for the development of political theory. In this manner, they revive forms of biologist politics. The worst of them are revived forms of social Darwinism that posits survival as a biological-political necessity and an ethical imperative, without reflecting on the question of ‘good life’ and the possible tragic conflict between clashing values and ideals. A further consequence of the biopolitics that dispenses with medical history or an apt historical epistemology is the obliteration of the problem of ideology through the flattening of discourse and reality. This illusion amounts to the equation of medical discourses (or *any* discourses) and the medical practices (*any* practices) but discourse and reality do not coincide, although the lack of apprehension of difference is precisely the goal of the ideology that was once condensed in the Thatcherian phrase “there is no alternative”⁸⁴.

Emancipation and the question of an emancipated science and technology can only emerge from criticism of scientist ideology and the anti-libertarian (exploitative and political) uses of science and technology as forces of world transformation and cultural hegemony. In order not to make the critique of science into a generalized and idle critique of science *tout court* (a sort of a-critically hypercritical anti-science), it is important to maintain the distinction between alienated science, technology and labour as they appear in specific societal and economic settings and the potential for non-alienated forms of knowledge and labour⁸⁵. In

⁸³ See also the debate that recently appeared in the journal “Studi Culturali”: AA.VV., *Contro la Theory? Dalla provocazione al dibattito*, “Studi Culturali”, XV, 1, 2018, pp. 67-106.

⁸⁴ M. Fisher, *Capitalist Realism: Is There No Alternative?*, Zero Books, Winchester 2009.

⁸⁵ J. Habermas, *Technology and Science as “Ideology”*, in *Toward a Rational Society: Student Protest, Science, and Politics* Beacon Press, Boston 1970, pp. 81-122; H. Marcuse, “Industrial-

connection with this, the question of the scientists and technologists' political responsibility for the function they have in society and the question about the relation and tension between expertise and democracy are of burning actuality⁸⁶.

That science and politics cannot be separated is evidenced by the case of pandemic management in history. We would like to stress that pandemic management has been connected with issues of internal surveillance as well as conflicts among European states as well as between European and extra-European states at least from the late Middle Ages on. Today's implementation of human tracing for sanitary reasons raises fundamental questions related to the future of mass democracies. Concerning the politics of health management, we argue with biopolitical theorists that there is an intimate connection between modern forms of politics and biomedical techniques but, against their flattening of the relation between theory and practice, we look at societal surveillance and geopolitics as *revealing of* not as *coincident with* modern political economy. Quarantine and health systems are the necessary flipside of trade and the enlargement of the economy from the Mediterranean basin to the Atlantic and the entire globe. International conflicts have always materialized through commercial and military battles by means of use and misuse of the quarantine, till nowadays, when the commercial battles among (blocs of) countries are played, for instance, through production, stock exchange listing, and approval of vaccines. The global commercialization of health (or global health), besides leading towards the exacerbation of health care systems versus trade interests, also contributes to avoiding considering any serious analyses on the structural, economic, environmental and sanitary causes of the pandemic. As an effect of these trajectories, focusing mainly on contagion leads to an undue neglect of its economic, sanitary, cultural and geopolitical factors. By contrast, we have argued that it is precisely the consideration of these coordinates that leads to a correct understanding of what a pandemic is and opens up a critical and emancipatory perspective on a science-technology freed from the hegemony of the economic and political dimension of global capitalism.

isierung und Kapitalismus," in O. Stammer (ed.), *Max Weber und die Soziologie heute: Verhandlungen des 15. Deutschen Soziologentages in Heidelberg 1964*, Mohr Siebeck, Tübingen 1965, pp. 161-180.

⁸⁶ G. Ciccotti et al., *L'ape e l'architetto*, cit.; G. Ciccotti, M. Cini, M. De Maria, *The Production of Science in Advanced Capitalist Society*, in H. Rose, S.P. Russell Rose (eds.), *Ideology of / in the Natural Sciences*, I, Macmillan, London, pp. 32-58.

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Authors' contributions

We collectively worked on this essay, which was the fruit of long-lasting conversations, scholarly exchanges as part of a larger network of political epistemologists.

Concerning labor organization, PO: initial conception and coordination; PO and GI: writing of introductory and concluding sections, as well as the methodological overture; FD: writing of the historical-critical section; CW and GG: writing on politics of life.

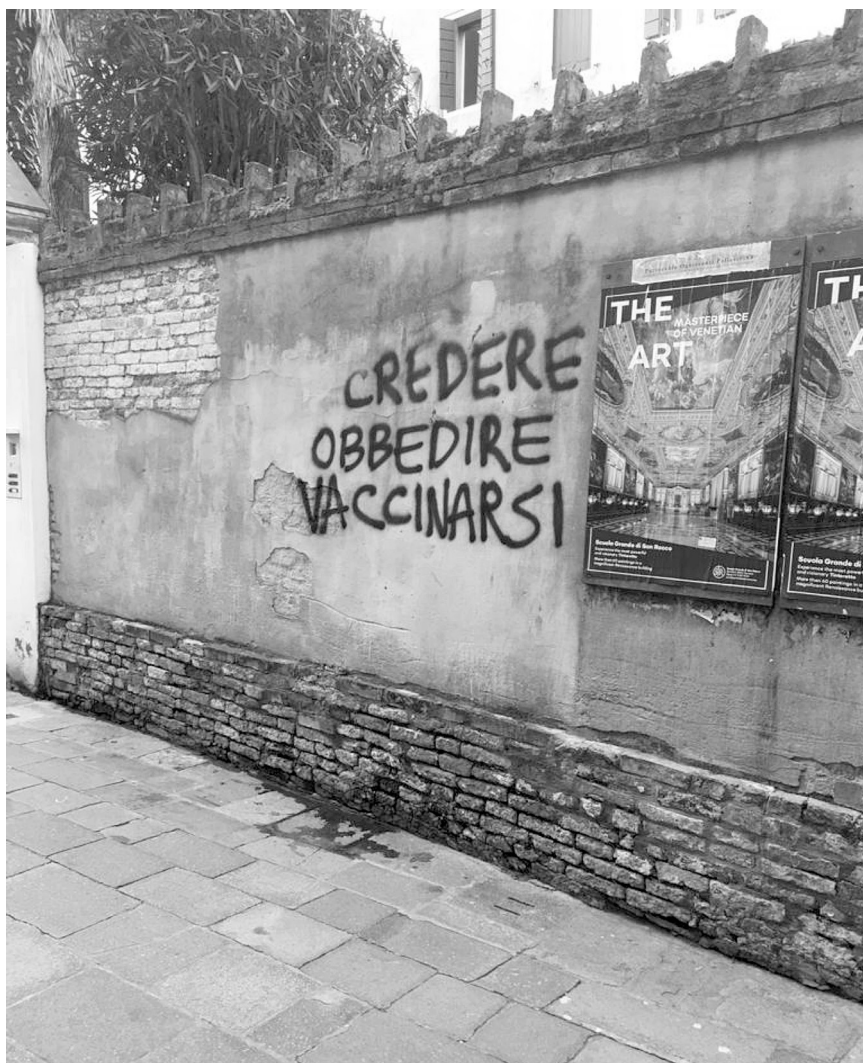


Fig. 1. An anarchic slogan on a wall of Venice (photographed in January 2021): “Believe, obey, get vaccinated.” Through a reference to a well-known Fascist slogan, “Believe, obey, fight,” it makes fun of the “faith-and-obedience” culture that the authorities currently foster to “fight” the virus.



Fig. 2. Sopa de Wuhan, Book Cover.

Recensioni/Reviews
Cronache/Conference Reports

Carmela Morabito, *Il motore della mente. Il movimento nella storia delle scienze cognitive*, Laterza, Bari-Roma 2020, 168 pp.

Il titolo suggestivo del saggio gioca sul doppio valore del genitivo che unisce “motore” a “mente”: tanto come genitivo soggettivo, quanto come genitivo oggettivo, “il motore della mente” esprime il programma dell’intero libro. Infatti ciò che plasma la mente risulta essere il movimento stesso del corpo mosso dalla mente. D’altra parte il sottotitolo dà profondità al programma, a indicare che l’intento del libro non è soltanto la presentazione di una nuova descrizione della mente quanto la ricognizione, nella storia della filosofia, della psicologia e delle neuroscienze, di un paradigma motorio affermatosi ultimamente ma riaffiorante da tempo nella cultura occidentale.

La rassegna storica descrive il lento superamento di un modello metafisico impostato nella sua versione moderna da Cartesio, ma risalente almeno sino a Platone: si tratta della mente intesa come *res cogitans* ontologicamente separata dalla *res extensa*, a sua volta superamento e perfezionamento della mente intesa come nocchiero del corpo. In altre parole questo saggio rappresenta un ulteriore tassello dello smantellamento della metafisica occidentale. Le neuroscienze confermano la necessità di adottare un diverso paradigma descrittivo della mente, nel quale la mente risulta radicata nel corpo e fondata sulle capacità motorie di questo stesso corpo. Il nucleo della mente non è la coscienza che riceve informazioni dall’esterno, le rielabora e infine comanda al corpo una reazione. Il suo nucleo è invece più profondo e più antico, radicalmente ancorato alla cinestesia piuttosto che alla percezione: l’operazione tipica della mente non è concepire un piano ma anticipare un movimento. Il nuovo paradigma della mente in quanto sistema motorio rivendica la matrice biologica del mentale: la mente smette di contrapporsi al mondo, il mentale al corporeo, il soggetto all’oggetto. Insomma decade l’antica dicotomia metafisica idea-

cosa o mente-corpo. Il nuovo paradigma, e questo è sicuramente più interessante ai fini dell'attuale filosofia della mente, mette in discussione anche la classica analogia cervello-computer: la mente non è solo il cervello, che a sua volta non è semplicemente un computer. Semmai la mente è un sistema motorio, il computer una macchina di calcolo.

Il cervello, in quanto elemento non esclusivo della mente, figura nel nuovo paradigma come macchina biologica non data una volta per tutte ma frutto dell'evoluzione, tanto biologica quanto storico-culturale. Questa prospettiva implica al contempo un'analisi fenomenologica dell'organismo nel proprio ambiente e un'analisi neurologica dei meccanismi del sistema nervoso. Una volta chiarita la "nuova" visione della mente in contrapposizione a una visione più "antica" e consolidata, l'Autrice ripercorre l'emergere del fattore chiave per il nuovo paradigma in una retrospettiva storico-filosofica, dedicando a questo sforzo la parte centrale e più ponderosa del libro (capp. 3-18), grossomodo da Cartesio alla scoperta dei "neuroni specchio".

L'idea che l'ambiente esterno si presenti al soggetto attraverso uno stimolo sensoriale e che in risposta il soggetto reagisca segue una descrizione epistemologicamente obsoleta. Al contrario mondo e mente si compenetrano, biologico ed epistemico si sovrappongono. Tuttavia nel corso della storia della filosofia l'analisi delle facoltà cognitive della mente ha a lungo puntato a mantenere aperto il fossato metafisico che nel XVII secolo Cartesio tracciò tra *res cogitans* e *res extensa*. A ben vedere, Cartesio non aveva solo dato una risposta sbagliata all'annoso problema mente-corpo, aveva piuttosto indirizzato il dibattito su un problema sbagliato. Cartesio riduce infatti il corpo a una macchina e la mente al *cogito*, cioè il primo a qualcosa che si muove e la seconda a qualcosa che produce rappresentazioni. Di conseguenza la mente appare solo come cosciente e attiva, tutto l'opposto del corpo. Gli studi più recenti invece mostrano che *la* mente e *il* corpo non esistono come entità separate.

L'Autrice indaga una storia della mente alternativa i cui protagonisti riconobbero l'insufficienza del modello cartesiano. Notoriamente questa alternativa è rappresentata dall'empirismo di Hobbes, Locke e Hume. Ma non furono questi i filosofi della mente che gettarono le basi per l'emergere del paradigma alternativo: essi vanno cercati piuttosto in autori come David Hartley (prima metà del Settecento), Erasmus Darwin (seconda metà del Settecento) e Alexander Bain (Ottocento), quest'ultimo propugnatore di un innovativo associazionismo sensomotorio (cap. 5), primo a suggerire che il motore della mente non sia la sensazione bensì il movimento. Tuttavia il superamento del dualismo ontologico, cioè la decostruzione del

modello metafisico per via sperimentale, attraversò l'Ottocento in parallelo alla conquista di spazi sempre maggiori da parte del paradigma sensomotorio. Poiché permaneva il pregiudizio ideologico di un sistema cerebrale inferiore motorio e un sistema cerebrale superiore cognitivo, dicotomia ancora espressione del più antico dualismo, intervenne uno spostamento della soglia verso l'alto fino alla caduta della distinzione ontologica tra movimento volontario e involontario e tra cognitivo e motorio.

La compenetrazione di psicologia e fisiologia avvenne grazie allo studio del riflesso, alla concezione del cervello come organo della mente, al superamento dell'illusione intellettualistica e in definitiva dell'antropocentrismo. All'inizio del Novecento si parlava ormai di intelligenza sensomotoria, di senso cinestetico, del cervello come macchina proattiva, di prospettiva ecologica ove mondo e mente si compenetrano. Nelle scienze cognitive post-classiche s'imponesse il paradigma dell'*embodiment*, cioè della mente incarnata, della mente estesa completamente naturalizzata, in un intreccio assai fecondo con la fenomenologia di Husserl e soprattutto di Merleau-Ponty. La mente incarnata implica il rifiuto del cognitivismo classico, della dualità mente-corpo, della sequenza input sensoriale output cognitivo, della metafora del cervello come elaboratore centrale, della separazione tra azione e percezione. In definitiva la mente non è solo incarnata ma anche estesa al corpo e al mondo: viene superata così la tradizionale dicotomia tra soggetto e oggetto.

Gli studi più recenti suggeriscono anche una plasticità peculiare della mente (cap. 17), incarnata cioè in un contesto corporeo interno e relazionale esterno, e in grado di autoorganizzarsi. Questo porta al compiuto superamento della metafisica del cervello, il quale si mostra ormai come organo in continua riconfigurazione e autoplasmazione. Il cervello è qualcosa in divenire di cui noi siamo soggetti-autori e prodotti, è un organo "aperto" che percepisce-agisce-conosce. La plasticità della mente e la centralità del movimento per la cognizione trovano conferma nella scoperta relativamente recente (fine anni Ottanta del Novecento) dei neuroni specchio (cap. 18), i quali si attivano quando compiamo una certa azione o quando vediamo altri compierla. Insomma, come scrive l'Autrice: "Aveva [...] ragione Darwin, quando teorizzava di ribaltare l'approccio tradizionale alla mente: per conquistare la cittadella della mente occorreva entrarvi dal basso, non partire dall'indagine dei processi cognitivi più evoluti ma dalle loro componenti più arcaiche dal punto di vista dell'evoluzione: viscerali, affettive, basilari" (p. 105). Il cervello non si è evoluto per pensare ma per agire e per anticipare le azioni degli altri. Il linguaggio rappresenta allora qualcosa di secondario o di superficiale rispetto al motorio

nella formazione della mente: i concetti riferiti ad azioni attivano nel cervello percorsi sensomotori legati al corpo e alle capacità di movimento. In tal caso cultura e biologia s'intrecciano nei meccanismi mentali.

La *summa* dell'intera analisi del rapporto mente-corpo conduce a una sorta di storia naturale della mente in una prospettiva evolutiva: la mente è emersa come prodotto naturale nel corso dell'evoluzione e la coscienza come prodotto sociale e culturale. In conclusione, dopo una lunga disamina storica ed epistemologica del riconoscimento della motricità come principio fondante la mente, i confini corpo-mente si sgretolano e così anche quelli corpo-protesi: ciò è possibile perché la struttura della mente è aperta, e dunque se il pensiero è cinetica, lo strumento è pensiero.

Tommaso Scappini

Christian W. McMillen, *Pandemics: A very short introduction*, Oxford University Press, Oxford 2016, 176 pp.

The current COVID-19 pandemic has swept the world at an unprecedented speed, closing societies, overburdening health infrastructures, and raising fear and anxiety around the world in just a few months' span. What separates COVID-19 from its predecessors might be the speed and the scope of its rapid contagion. But in many other ways it is a manifestation of history repeating itself. "Pandemic: A Very Short Introduction" (2016), by Christian W. McMillen, provides a comprehensive and concise description of the most important historical pandemic and epidemic diseases: plague, smallpox, malaria, tuberculosis, influenza, and HIV/AIDS. It also discusses several of the more recent epidemics, like Ebola, Zika-virus, and avian flu. Even if the book was published pre-COVID-19 pandemic, in 2016, it remains highly accurate and informational for today's readers.

The book's aim is to introduce readers to the rich history of pandemic and epidemic disease and suggest that much of the ways we confront such things now have been shaped by the past. Throughout human history, especially the last millennia, pandemic and epidemic diseases have been our regular visitors. Their severity and scope have varied, and so has their identity and ability to induce fear. What unites each pandemic is that they all depend on a dense, mobile, and susceptible population of hosts. The central argument of the book is that pandemics can have a great impact on humanity's history, and in return, our social behaviour can influence pandemics. For instance, one can hardly overestimate the impact of the Black

Death on European populations and societies in the 14th century, or the impact of smallpox on the American Indians in the 16th century. On the other side, biomedical breakthroughs, like vaccines and antibiotics, improvements in social conditions, and deployment of public health measures, like quarantine and restrictions to travel, have on many occasions successfully restrained the spread of diseases or even eradicated them from the planet, like in the case of smallpox in the 1980s. History is full of cautionary tales, success stories and lessons to be learned. It is our task, according to McMillen, to retain this knowledge and learn from the past.

The book presents the histories of each major pandemic disease from their first known occurrence up to this day. In each chapter McMillen provides the basic information of the disease and its treatment. The book is highly interesting from the medical and epidemiological standpoint, but the most intriguing feature in the book, however, is the way in which McMillen analyses the broader social, political, and cultural aspects of each pandemic.

Christian McMillen is a Professor of History at the University of Virginia, where he serves as the Associate Dean of social sciences and teaches courses on American Indian history and the history of epidemic disease. His expertise in history of diseases and social sciences offers a great asset in describing the evolving relationship between pandemic disease and societal change. In each chapter he asks questions about the important social, political, cultural, economic, religious, and demographic aspects of the pandemic at hand. How did the pandemic disease influence the society and how was it perceived and explained by its contemporaries? What kind of measures were taken, and how did they work? As a result of asking and answering these questions, recurring patterns, tendencies, and geographies of pandemics begin to emerge. One of the most certain, and tragic, tendency regarding pandemic diseases is that they tend to hit harder minorities, the poor and the weak. Poverty creates favourable terrain for infectious diseases, because of weakened immunity of the population and lack of resources, medication, and access to clean water. Even the most effective biomedical solutions cannot bring sustainable health and security, if the general living conditions remain poor. The reason why many old pandemic diseases, like malaria, TB, and HIV/AIDS still linger and occasionally grow into epidemics in the Global South is most often due to the lack of resources.

In the book McMillen provides insight into the cultural and social aspect of historical pandemics by drawing material from historical sources, including old medical records, ecclesiastic texts, journals, diaries, literary pieces, and political writings. Illustrations and numerous references to historical texts make the text rich, polyphonic, and very interesting to fol-

low. The book is written in an academic but reader-friendly manner – clear, but without losing too much of its specificity. The book includes an index and a broad list of references and recommendations for further reading in the back. This provides all the more reason why the book makes an excellent primer.

The strength of the book is in its way of describing cultural and societal change relating to the pandemic outbreaks. While providing clear and thorough scientific explanations of the diseases, the book's primary focus is, in the end, strongly related to humanity's responses to pandemics. It illustrates in great detail humanity's changing attitudes towards pandemic threats: for example, the explanations concerning the origin of the plague varied from God's wrath to miasma and contagious seeds, until the bacteria *Yersinia pestis* was discovered in 1894. Throughout the centuries many scapegoats, often Jews or other minorities, were wrongly accused of bringing the plague and persecuted and even killed for it. The book illustrates that to understand the history of pandemic disease, one needs first to understand the social behaviour of human communities and societies.

The main weakness of the book is that it does not have a chapter about COVID-19. This was not the fault of the writer, however, since the book was published well before the pandemic. In fact, in his epilogue McMillen managed quite accurately to predict the current pandemic. If there were to be a second edition of the book – with preferably an extra chapter for COVID-19 – one thing that could be improved would be to broaden the epidemiological angle of the book. Especially towards the end of the book McMillen's tone changes somewhat, as he commences to criticize the WHO and the other leaders in the world of global health. Even if I find his criticism well-founded, it sometimes disturbingly overshadows the medical and epidemiological explanations given to the diseases.

On the whole, the book succeeds in fulfilling its task, which is to offer a very short but comprehensive introduction to the history of pandemic and epidemic diseases. The book excels in its ability to provide such a rich historical and socio-cultural narrative to pandemic diseases and humanity's responses to them. Despite the fact that it was written before COVID-19, the book succeeds to remain accurate and topical. This book is the perfect choice for any reader, who is looking for an easy, informative and enjoyable primer for pandemic and epidemic diseases.

Sini Tuohonen

Barbara Stiegler, *De la démocratie en pandémie. Santé recherche éducation*, Gallimard, Paris 2021, 64 pp.

The philosophical pamphlet written by Barbara Stiegler represents a courageous and praiseworthy attempt to sketch a critical but reasonable philosophical perspective about the impact of the COVID-19 pandemic on democratic politics, public health, and education in Western countries. In this review, I will focus on the aspects that I found valuable and meaningful for a rigorous analysis but conclude that her work partly fails in reaching the proposed aims.

Describing the events that characterized the actuation of the lockdown in France during the first wave, Stiegler highlights rather well at least two problems that affected pandemic management and are still negatively influencing the realization of effective public health policies. The first issue concerns the lack of trust between citizens and their political representatives. This complication did not rise with the pandemic for the first time. On the contrary, the progressive deterioration of reciprocal trust between the political leaders and citizens is a problem that has been afflicting many European democracies and the United States over the last ten years. However, with the beginning of the pandemic, as Stiegler rightly notices, such deteriorated institutional relationship has been reinforced by the French government in several ways. The tendency to hide any political accountability behind the veil of the idea that every public policy was purely science-oriented was misleading and counterproductive. Besides, to opt for communicative strategies that were mainly based on nudging technics instead of public consultation reinforced in citizens the feeling of being treated like children instead of responsible adults.

This last point is strictly connected to the second relevant problem that, in this case, clearly emerged in social democratic and liberal democratic countries as the pandemic started: the failure of the public and scientific communication in explaining properly the known and, especially, the unknown about the nature of COVID-19. The lack of clear communication concerning the information available about the biological features of the virus went hand in hand with the incapacity of the political elites, the scientific community, and media to effectively explain the ratio in support of the implementation of non-pharmaceutical measures. These were perceived (and still, they are) as arbitrary and disproportionate by most of the population, which was not used to massive health policies that are common and accepted in other parts of the globe.

Stiegler's critique against the policies that, in the last years, have weakened the public health system and the public educative structures, is valuable too. These are two institutional organizations that will be fundamental in facing the challenges posed by climate change, overpopulation, globalization of free market and commodities exchange, and, consequently, possible future pandemics. To dismantle them, or subordinate totally their functioning and ratio, which are not productive, to a system of allocation of the resources based on demand and supply risk to damage the safeguard of the collective rights to education and health. Their realization cannot be dependent only on decision procedures that mediate between different particular interests.

Nevertheless, some conceptual points seem to be problematic in Stiegler's approach. The first one concerns the idea of democracy that constitutes the background of Stiegler's analysis. Her conception appears excessively inclined to identify the essential core of democratic life with the political agonism and critique. There is no doubt that, nowadays, there is a growing and positive emergence of new forms of indirect and informal political power. Through the exercise of veto by social movements, for instance, citizens can express their civic activism positively and productively. However, from a historical point of view, democratic institutions have also embodied public procedures and practices that have aimed at neutralizing the influence of small groups of power in public decision-making. The legitimacy of such institutions, which has been mainly governed by the public administrations, scientists, experts, and public officials, has been grounded mainly not on the idea of direct participation, but on the impartiality of their procedures and the scientific approach to the problems that regard the collectivity. This does not mean that a democratic and more inclusive reform of such institutions would be meaningless or useless. Simply, not every wrong, excessive, or arbitrary measure that has been realized in the first phase of the epidemic in the Western world was the outcome of the anti-popular prejudice of the political elites of democratic countries. Nor any failure was solely the result of elites' lack of preparedness or their will to take advantage of the crisis circumstances for imposing structural reforms that point at privatizing the public sector or weakening the democratic participation of citizens.

In her polemic attitude toward Macron's government, Stiegler seems to forget that public policies are usually enacted by decision makers observing a criterion of progressive balance between precautionary and proportionality principles. During non-emergency scenarios, democratic governments have time to gather scientific evidence before enacting and enforce-

ing laws. In such circumstances, it is possible to reconcile the conflict between civil liberties, democratic life, and public health in a non-traumatic way. However, in a fast-moving pandemic, characterized by the lack of sound scientific knowledge of the phenomenon, governments are forced to make urgent policy maneuvers that can partially impact civil liberties. It can be the case that, for quite an extended lapse of time, prolonged deliberation and legislative debate are not possible, and that actions are taken based on executive orders, pursuant to emergency legislation.

In the light of these considerations, the worries expressed by Stiegler, concerning a structural disempowerment of democratic customs and institutions by means of the normalization of the emergency legislation have been denied by the following events. First, even during the pandemic, many strikes and public rallies have been organized by riders, the BLM movement, environmental activists, anti-lockdown protesters, waged workers who were asking to work in a safe and healthy environment. Regardless of any moral and political evaluations about the claims of these collective subjects, it can be stated that emergency laws have not annihilated the space created by democratic institutions for social conflicts and agonistic politics. On the contrary, a huge portion of citizens has not given up the idea of bottom-up political participation. In this regard, Stiegler's concern about the pervasive influence of nudge technics and economy on public policies and democratic politics is clearly disproportionate.

Second, starting from the second wave, it is a matter of fact that, apart from the UK, under the pressure of civil society, most democratic governments have opted not for rigid lockdown policies, but mitigation strategies based on the focused and regional actuation of non-pharmaceutical measures. Besides, even those countries that, at the beginning of the pandemic, have enacted martial measures or invasive test and trace strategies (like New Zealand, Australia, South Korea, Vietnam) have not fallen into a dystopic nightmare of restrictions and oppression.

Finally, it is necessary to underline the serious logical contradiction in which Stiegler runs into since the beginning of her pamphlet. She rightly defines the COVID-19 pandemic in terms of a syndemic. At the same time, Stiegler identifies the Chinese Republic as the main causal, moral, and political agent that is responsible for the beginning of the pandemic and the subsequent advent of emergency laws. However, to talk about a syndemic means to underline the social origins of a biological phenomenon. It means not only to highlight the fact that COVID-19 is hitting harder those individuals and groups that already suffer from health inequalities, economic injustices, social marginalization. To take into account

the epidemiological concept of syndemic implies also the idea that, for a better understanding of the whole situation, we must focus on the analysis of the demographic reasons and socio-economic structures that have favored the spread of COVID-19 on a global scale.

If it is so, to accuse a single political and institutional entity of being the main responsible of the present global health emergency can lead to an unjustified racialization of the phenomenon. On the contrary, instead of looking for an external enemy or agent that has corrupted our democratic society, we should critically discuss the role that the global market, the present mode of production, and our technological infrastructures have had in triggering and aggravate the current syndemic. Charging the Chinese people, or depicting COVID-19 as an Asian virus, is as unfair as considering only individual behaviours and mistakes as the main cause of the millions of deaths we are going to count due to COVID-19.

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