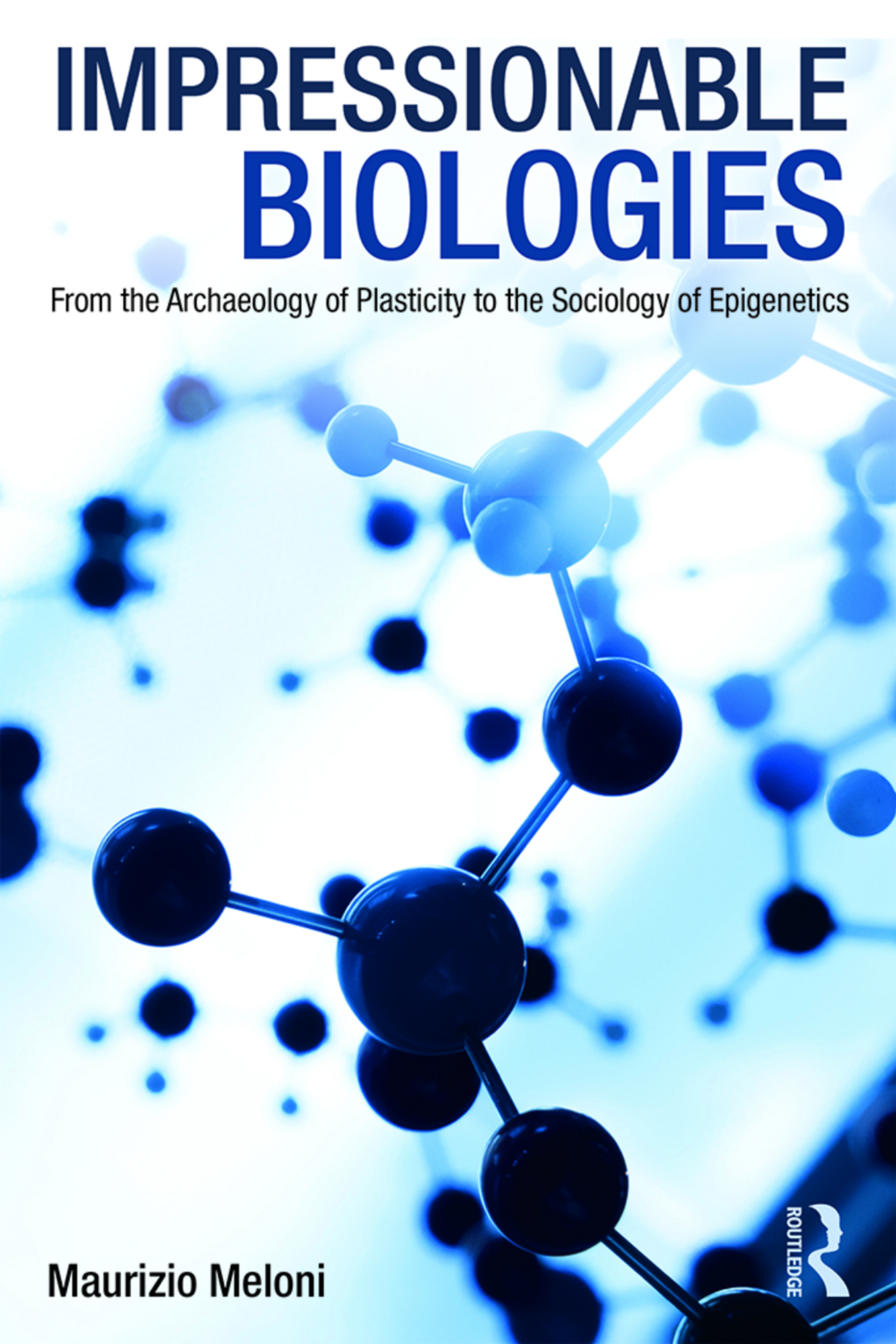
IMPRESSIONABLE BIOLOGIES

From the Archaeology of Plasticity to the Sociology of Epigenetics



Maurizio Meloni

ROUTLEDGE

With this impressive genealogy of the thinking that underwrites current interest in epigenetics, Meloni provides us with a much-needed frame for one of the most compelling ideas in contemporary bioscience. This book should be required reading for anyone curious about the ways that we, as living beings, carry the past both with and within us.

Ed Cohen, Professor of Women's and Gender Studies,
Rutgers University, author of *A Body Worth Defending*

Impressionable Biologies, a tour de force, engages with a concept of inherent bodily plasticity recognized as one form of another from classical humoralism to present day epigenetic effects due to the increasingly toxic environments in which we now live.

Margaret Lock, PhD, author of *The Alzheimer Conundrum: Entanglements of Aging and Dementia*

Impressionable Biologies

During the twentieth century, genes were considered the controlling force of life processes, and the transfer of DNA was the definitive explanation for biological heredity. Such views shaped the politics of human heredity: in the eugenic era, controlling heredity meant intervening in the distribution of "good" and "bad" genes. However, since the turn of the twenty-first century, this centrality of genes has been challenged by a number of "postgenomic" disciplines. The rise of epigenetics in particular signals a shift from notions of biological fixedness to ideas of plasticity and "impressionability" of biological material.

This book investigates the long history of beliefs about the plasticity of human biology, starting with ancient medicine, and analyses the biopolitical techniques required to govern such permeability. It looks at the emergence of the modern body of biomedicine as a displacement or possibly reconfiguration of earlier plastic views. Finally, it analyses the return of plasticity to contemporary postgenomic views and argues that postgenomic plasticity is neither a modernistic plasticity of instrumental management of the body nor a postmodernist celebration of potentialities. It is instead a plasticity that disrupts clear boundaries between openness and determination, individual and community, with important implications for notions of risk, responsibility and intervention.

Maurizio Meloni is a social theorist and a science and technology studies scholar. He is the author of *Political Biology* (Palgrave 2016), co-editor of *Biosocial Matters* (Wiley 2016) and chief editor of the *Palgrave Handbook of Biology and Society* (2018). He is Associate Professor of Sociology at Deakin University, Australia.

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From the Archaeology of Plasticity to the Sociology of Epigenetics

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Preface and acknowledgements

Problematizing the turn to plasticity

Since the turn of the twenty-first century, human biology has become seemingly more sensitive and perhaps vulnerable to exposure to biophysical environments and sociocultural experiences. Scientific claims about the openness of the brain, the body, genome expression and even biological heredity to history, biography and culture have become increasingly visible over the last two decades. Paralleling a similar process in the neurosciences, the powerful rise of epigenetics and the consolidation of developmental origins of health and disease (DOHaD) since 2000 signals a shift away from notions of biological fixedness and toward ideas of "impressionability" of biological material – ideas that seemed forgotten during most of the twentieth century at the peak of genetic explanations. Rather than being hardwired, gene expression, brain structures and biological bodies are rewritten as alterable and capable of modifying themselves in response to pressures from inside and outside the body itself. In a word, they are described as *plastic*. Arguments about "biosocial research" and "biosocial entanglement" also reflect this awareness of a multi-causal and multi-level co-determination of social and biological matter, of what lies beyond and within the skin. Alongside these epistemic shifts, a whole new landscape of ethical and sociological quandaries is rapidly unfolding. In this landscape, some of the conventional dichotomies forged during the last century are rapidly becoming obsolete: that biological heredity is not environment and environment is not heredity; that cultural factors are above the skin and not in the gut, the bones, or the genes; that genes are

either the bases of behaviours or are irrelevant to them; that if race is a social construction, it is not a biological reality; that biological explanations are individualistic and erase social factors, while sociocultural explanations omit biological embedding; that heredity stops at birth and is only contributed to by biological parents; that plasticity is counter to biological determinism and racialism, and taking the side of nurture is more progressive than endorsing the stability of traits in developmental debates.

Rather than examining these claims about plasticity directly in a prescriptive fashion, this book takes a longer genealogical perspective to suggest a more complicated state of affairs about the self-proclaimed revolutionary nature of these ideas. This *longue durée* history focuses on the widespread ancient and early modern belief in the plasticity of biological matter, its permeability to surroundings, the link between environment, food and health, and the biopolitical techniques required to govern a porous body. Rather than simply the latest episode in a history of innovation, it sees the present challenge to biological fixedness as encompassing the notions of multiple historical times and perturbingly resonating with older and non-Western epistemologies of the body.

The book problematizes the ubiquitous claim that epigenetics and related ideas of plasticity are "a break from past thinking" about heredity (Bonduriansky and Day, 2018). It reminds the reader that past thinking about heredity (i.e. genetics) was in itself a huge (revolutionary) break with traditional views of heredity and generation.[1] These older views displayed some of the characteristics (including a belief in parental and ancestral influences on heredity, especially maternal) that are resurfacing today in the molecular language of twenty-first-century biology (see Zimmer, 2018: 542–545). If plasticity means an ongoing interaction with the surrounding environment, and biological matter is always nurtured and situated, corporeal plasticity seems the standard, not the revolutionary, view in a global history of body–world configurations; at least, that is, before the rise of the modern biomedical body in Europe after the second half of the nineteenth century. Rather than an explanation of plasticity, the underlying question emerging from this book is the opposite: how did biological fixity (to a certain degree) and abstract universality of the body come into being? How did nineteenth-century European biology come to suggest an idea of relative insulation of the body, heredity and internal milieu as a condition for independence, freedom and individuality (Bernard, 1878; Weismann, 1891)? How did such views later come to dominate the twentieth century and steer competing paradigms?

By "conjugating" (Anderson, 2009) knowledge and ethical visions of the body generated by the latest advancements in molecular biology with a range

of discourses about biological matter preceding this nineteenth-century modernistic break, this book raises questions about the temporality, novelty, direction and pace of change in historical knowledge. It points to a deeper genealogical tree for the epigenetic body that is well beyond the controversial "return of Lamarckism", given that I situate Lamarckism within a much older history of plasticity of organisms to their surroundings. When William James claims that pre-Darwinians "thought only of adaptation" and "made organisms plastic to environment" (1988), I take this notion seriously and look at it as an intellectual thread to cover periods well before modern evolutionary debates.

To offer an intellectual map beyond twentieth-century biology–society debates, *Impressionable Biologies* follows three axes of analysis: science, knowledge and power.

1) The scientific axis addresses a growing obsolescence of modernistic views of the body, biology and heredity based on notions of a secure and unique individual core, a relative separateness from environmental factors, and the skin as a well-defined boundary between inner and outer, the biological and the social. At the scientific level, this obsolescence is mostly driven by the awareness of a growing number of anomalies in the long-held "normal" views of genetic functioning that were forged during the twentieth century. Hype and uncertainties are far from rare in contemporary challenges to genetic determinism, and many emerging findings in epigenetics or microbiomics still await validation in what is called the "postgenomic era". However, a facile critique that points its finger at sensationalistic findings would obscure the impressive growth of research and integration between emerging programs, which genuinely challenges and even violates long-held views in biology. Often the emphasis of these novel findings is about bringing the environment into the genome. And yet, one of the most intriguing aspects of epigenetic research is not the addition of the environment to an already existing genome, but the entire reconfiguration of the ontology of the genome. The gene is no longer experimented on and represented as an informational medium, but as a very material and impressionable body that brings back to actuality ancient metaphors of plasticity as marking and imprinting. This embodied nature of the genome may be used to challenge the flatness of the digital language of molecular biology.
2) The knowledge axis extends my previous argument (2016) about a return of the repressed in contemporary epigenetic research, or that scientific time future may be – in some cases at least – "contained in time past"

(Gissis, 2017). However, here, the "repressed" is not just nineteenth-century soft heredity but ancient, early modern and non-Western body–world configurations based on ideas and practices of bodily fluidity. Notions like the maternal imprint, the specific connection between body and place, the environment as a bioactive force, the blurring of the boundary between food and drug, the porosity of heredity to ancestral events, and even the inheritance of acquired behaviours, pangenesis and telegony (notions which have been recently evoked in molecular forms in epigenetics[2]) have always been well known in ancient, early modern and non-Western medical doctrines. It is this molecular resurfacing of past tropes implied by epigenetics that offers a unique opportunity to question polarities between "traditional" and "modern" knowledge. By focusing on how bodies are rewritten as plastic and vulnerable in epigenetics, the book may contribute not only to challenging the congratulatory rhetoric of innovation in contemporary life sciences but also to focusing on forms of epistemic hybridity where past and present, centre and periphery, global and situated exist in a deeply entangled way (Raj, 2013; Anderson, 2014). This means, genealogically, the possibility of a reappraisal of counter-traditions of the body as genuine sites of knowledge production. Where one sees the accumulation of pacified knowledge, genealogy reveals bellicose relationships.

3) The power axis highlights the complex coproduction of the political and the biological in the history of the body and the legacy of the politics of plasticity, at both the individual and the collective level. By focusing on the government of malleable bodies – always porous to environmental influences – the book sheds light on an alternative form of biopolitics and challenges views of an inherently liberating potential of biological plasticity. Building on the longer history, it dissects the contemporary implications of corporeal and genomic plasticity and (re-)emerging connections of environment and disease for notions of risk, responsibility and intervention. If the body is rewritten as permeable to its genomic core, it is also vulnerable to new risks and amenable to new forms of intervention, particularly in special windows of biological sensitivity. During these peaks of plasticity, prevention and other policy initiatives are described as more effective, but the lasting impacts of negative experiences are also deemed more significant and difficult to correct.

Finally, the book addresses the impact of epigenetics on existing notions of plasticity in the life sciences. Epigenetic research does not exhaust plasticity, a complex term that encompasses multiple research programs in biology,

often with competing meanings. However, epigenetics is rapidly becoming a key mechanism in several iterations of plasticity, especially in neuroscience and gene expression. Epigenetics, I argue, contributes in this way to shifting the overall inflection of the term across the biosciences. It brings to the fore a more complex meaning of plasticity that is less about potential for reorganization and optimization and more about absorption of environmental disruptions, inertia and viscosity of long-term effects. This is somehow a bleaker and certainly more sobering inflection of plasticity, which is far from being the opposite of stability or even fixity (Bateson and Gluckman, 2011). It is a plasticity of enfoldment in ancestral histories and entanglement in places that challenges both modernistic and postmodernistic appropriation of the term as, respectively, a property securely in the possession of the sovereign consumer or a symbol for infinite freedom and fluidity of identity.

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Melbourne (Australia), June 2018

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Notes

1 In politics, the term "counter-revolution" is often used to describe a break that removes and overturns the conditions of a previous revolutionary break; however, to think of the current challenges to the modernistic body of biomedicine (and its views of heredity, reproduction and relationships to the environment) in these terms would render too simplistic the argument here advanced about the coexistence of multiple temporalities in the history of science.

2 For molecular versions of inheritance of acquired behaviours, see Bohacek and Mansuy (2015). For pangenesis (direct communication between somatic and germ cells) in which exosomes potentially play the role of Darwin's gemmules, see Zimmer's comment (2018: 545) to Cossetti et al. (2014), and Sharma (2017). For molecular versions of telegony (how a *previous* mate's features are passed to offspring), see Crean et al. (2014).

An archaeology of plasticity

1

Living in postgenomic times: Of imprinting and plasticity

Claims of a new entanglement of bodies and the environment are increasingly relevant in postgenomic models:[1] "the life sciences are generating a transformative view of the biological body not as fixed and innate but as permeable to its environment and, therefore, plastic" (Mansfield, 2017: 355). Since the early 1990s there has been much emphasis on the brain's synapses and gross organization as sculpted by social and cultural influences, even in adult life (Clark, 1998; Glannon, 2002; Park and Huang, 2010; Overgaard and Jensen 2012; Rees, 2016). Now, fields like *environmental epigenetics*, *developmental origins of health and disease* (DOHaD) and *microbiomics* lead even wider arguments about the dynamism of biological matter (Charney, 2012; Majnik and Lane, 2015; Moore, 2015). These fields have shown how the human body is permeable to environmental effects (e.g. toxins, food and socioeconomic status) to its genomic core, entangled inseparably "with environmental forces (macro and micro) from the moment of conception on throughout life" (Lock, 2015: 151).

A wealth of evidence has accumulated since the early 2000s that not only is the human brain plastic, and hence changeable at the structural and functional level (Rubin, 2009; Rose and Abi-Rached, 2013), but also the microbiota and epigenome are moulded by the impact of food, lifestyle, toxins, chemicals, stressors and socioeconomic factors. Environmental or social epigenetics is the most well-known example of this emerging interest in the biological embedding of social experience and the appreciation of *the power of the environment* in explaining health trajectories, development and

biological identity. By showing how various material instantiations of social life become literally embodied in the epigenome, epigenetics is said to illustrate how *the environment gets inside the body* and makes "the boundary of the skin of little significance" (Landecker and Panofsky, 2013: 339, referring to Michael Meaney's work). Chiselled by the incessant workings of external forces, postgenomic bodies are described nowadays as fully absorbed in their surroundings (Solomon, 2016): the boundaries between the body and the outside world become uncertain. This is not quite the same as saying that genes and environment "interact", as we have known for the whole of the twentieth century (Hogben, 1933; Tabery, 2014). In postgenomics the environment is no longer a mere *container* for gene expression (Stallins et al., 2016); it is increasingly seen as a productive, bioactive force (Landecker, 2011), an inducer and generator of phenotypes (West-Eberhard, 2003). Even in terms of biological capitalism, postgenomics introduces a different logic that makes not just DNA sequences alone but the "whole spatial and temporal contexts and circumstances surrounding DNA" a new potential source of biovalue (Stallins et al., 2016).

Changes in evolutionary thinking are also significant: the formative power of the environment is wielded not only via indirect selective pressures, as in the classical neo-Darwinian account; the emerging logic of epigenetics now implies that the environment directly instructs the organism (Jablonka and Lamb, 2014). This reconceptualization has an impact on the way in which bodies are rewritten: not just as "reacting to" or "withstanding" the environment but as "composed of transduced representations" of it (Landecker, 2016: 87). Since external conditions are understood as *reflecting directly*, at the molecular level, in the body's "internal biological changes", a model of *imprint* replaces one of random genetic mutation (Lappé and Landecker, 2015). Metaphors of writing, marking, coating and labelling, as well as notions of memory, scars and erasures, have nowadays become widespread in the epigenetic landscape.

If imprint is a key metaphor for conveying the notion that the environment leaves a durable mark on the genome, *plasticity* is probably the word that best captures the spirit of postgenomic times. Plasticity, which the Oxford English Dictionary defines as "the ability to be easily moulded or to undergo a permanent change in shape", is a very complex notion. It is too often confused with its antonym,[2] *elasticity*. The difference between plasticity and elasticity is obvious in the science of matter. While elasticity is the capacity to regain an original form after the deforming pressure has ceased, plasticity is about undergoing a permanent change:

> If a coiled spring is pulled *beyond the limits of elasticity*, it will be *permanently elongated*. Provided that the spring does not break, the change is *plastic*.
>
> (Bateson and Gluckman, 2011: 31)

However, this distinction is more blurred in biology, where plasticity often flirts with elasticity or even *polymorphism* (the possibility to assume a nearly infinite number of forms), and is too often taken as equivalent to "change", "malleability", "reversibility" or "tractability". Its multifarious history reveals, however, a more complex polysemy, and an association with ideas of stabilization and retaining of forms after a perturbation. This connotation of plasticity as continuous with stabilization (Bateson and Gluckman, 2011), which had been neglected in modern writings, is coming powerfully back to the fore nowadays. As I will argue in this book, this is mostly an effect of emerging claims in epigenetics and related programs such as DOHaD, which explains health trajectory as the durable result of *in utero* effects.

Contemporary plasticity

Plasticity is today a trendy catchall term "encompassing multiple processes regulated in a variety of different ways" (Bateson and Gluckman, 2011: 5). In contemporary life science, plasticity appears in many guises: synaptic, morphological, immunological, not to mention psychic, behavioural and mental. Plasticity spans a number of cutting-edge research programs, including cloning and stem cells (plasticity as reprogramming of cell fate), immunology (producing antibodies to pathogens not encountered before), neuroscience (plasticity as rewiring of synaptic connections, even in the adult brain), and epigenetics (malleability of genomic expression). Due to their impact on notions of corporeal plasticity, phenotypic and developmental plasticity are the two areas of major interest in this book. *Phenotypic plasticity* is "the ability of individual genotypes to produce different phenotypes when exposed to different environmental conditions" (Pigliucci et al., 2006; Nicoglou, 2015, 2018); *developmental plasticity* (which looks at the same phenomenon from a developmental angle and is often used as a synonym) is usually defined as the capacity of an organism or the body to react to an environmental input "with a change in form, state, movement, or rate of activity" (West-Eberhard, 2003: 34). Reference to these notions brings to the forefront the capacity of

humans to adjust quickly and flexibly in "heterogeneous environments" (Gabriel et al., 2005; Kuzawa and Bragg, 2012), relying less on forms of "genetic commitment" (Wells, 2012: S470).

Given this multifaceted situation, the semantic "unity" of the term is by itself questionable. As scholars in Science and Technology Studies (STS) know, it is best in this case to understand scientific terms as the result of a complex negotiation across multiple scientific communities shaped by different "research questions, [and] practices of scientific measurement" (Pitts-Taylor, 2016: 36). Plasticity, therefore, ultimately comes in the plural, and genealogy is exactly what is needed to diffract this polysemy of the term into its multiple instantiations.

The flourishing status of plasticity in several scientific research programs and social science writings shows a significant discontinuity with last-century debates. One visible case is evolutionary biology. For a large part of the twentieth century, with few pioneering exceptions, the term was considered a simple "nuisance" (Forsman, 2015: 276; see alternatives in Weber and Depew, 2003; Morange, 2009; Nicoglou, 2018). A key text of twentieth-century neo-Darwinism, Ernst Mayr's 800-page *Growth of Biological Thought* (1982), features the word "plastic" just twice, firstly to be criticized as an antiquated view and secondly in the sense of modern surgery. The contemporary scenario is very different. Plasticity research "has grown tremendously from ten papers published per year before 1983 to nearly 1300 papers in 2013" (Forsman, 2015: 282). This increase is paralleled only by that of epigenetics, which has escalated in the last decade by comparable figures (Meloni and Testa, 2014; Skinner, 2015). The two areas support each other and in several cases even overlap, with epigenetics offering a plausible molecular but non-genetic mechanism for biological plasticity and rapid adaptation to changing environments (Kuzawa and Bragg, 2012). In terms of its social translation, "plasticity" is currently used to describe the openness of the body and the brain to complex environmental interactions throughout life, and particularly in specific critical periods of heightened sensitivity (especially early-life experiences). It is invoked to mark a shift from premillennial notions of biological fixedness and genetic hardwiring. It is used as a powerful rhetorical platform drenched in hope to suggest that brains can reprogram and repair themselves and bodies are always open to forms of intervention to optimize biological fitness, enhance therapeutic potential and even correct past injustice (Duffau, 2006; Moller, 2006; Rubin, 2009; Rose and Abi-Rached, 2013; Lloyd, 2018; Lloyd and Raikhel, 2018).

Plasticity, especially in social science quarters, has a strong allure, and is very often captured into a discourse of *social progress*. Boas famously played the card of the "instability or plasticity" of human racial types (Boas, 1912: 557) against typological racists and American eugenists, inaugurating a long tradition of liberal anthropology based on plasticity *against* biological fixedness. The post-Boasian tradition further reinforced this association of values, neatly aligning a discourse of fixity with one of exclusion and a discourse of plasticity with one of emancipation. This polarized strategy was probably favoured by the specific research design that American anthropology privileged (Hulse, 1981): physical changes (such as increase in stature) in the descendants of poor or rural migrants moving to the USA (Shapiro and Hulse, 1939; Goldstein, 1943; see also Lasker, 1952, 1954). In her review, Bernice Kaplan (1954) discusses twenty-five studies on human plasticity, of which only a few referred overtly to its negative effects, one written by a non-American author (Ivanovsky, 1923, on the effects of inanition in Russia). This debate is so value-laden that nowadays, one century later, attacking Boas' study (Sparks and Jantz, 2003) still has deep political implications.

However, this one-sidedly emancipatory use of the term "plasticity" is one of the most important obstacles to an appreciation of its plurality of meaning. Plasticity is an inherently dualistic term, caught between *openness* and *determination, agency* and *vulnerability* (Paillard, 1976; Malabou, 2005; Pitts-Taylor, 2016). Analogous to the Greek *phármakon*, which can cure and poison at the same time (Derrida, 1981), plasticity in emerging styles of epigenetic reasoning is the domain of a profound indecision compatible with conflicting social and ethical scenarios (Lloyd, 2018; Lloyd and Raikhel, 2018). This fundamental ambiguity of the concept of plasticity between creation, reception and annihilation of forms (Malabou, 2005; see also 2009, 2010) will be turned in this book into a heuristic for unpacking its rich polysemy across various epochs. A *longue durée* and non-linear history of the plastic body shows how each of its conceptual facets may have become prevalent in certain historical moments, at the expense of others. Its ambiguity becomes here the very source of its productiveness (Rheinberger, 2003).

Plasticity, etymology and history

Even a quick look at the etymology and recent history of the term aptly demonstrates some of the traps connected with it. As for its etymology, plasticity comes from the Greek *plassein*, which means to mould, shape or form, and by extension, to fabricate, forge, sculpt and train someone; hence the

adjective *plastikos*, a thing to which a form can be assigned, but also all the arts and techniques by which a form can be produced:

> "Plastic" as an adjective has two meanings. On the one hand, it means "to be susceptible to changes of form" or "to be malleable." Clay, in this sense, would be "plastic." On the other hand, it means "having the power to bestow form," as in the expression "plastic surgeon" or "plastic art" understood as "the art of modelling" in the arts of sculpture or ceramics. Plasticity describes the nature of that which is plastic, being at once capable of receiving and of giving form.
>
> (Malabou, 2005: 65)

A similar polarity arises when observing the nature of plastic matter. In his *Meteorology*, Aristotle highlights the singular nature of plasticity as located between two poles: a hardness that resists all modifications, and a softness or fluidity that does not retain any. Notably, this definition came many centuries before William James' often cited and, in fact, derivative definition of plasticity as "semi-inertness" – "the possession of a structure *weak enough* to yield to an influence, but *strong enough* not to yield all at once" (1890: 105; my italics).[3] Aristotle writes:

> Some things, e.g. copper and wax, are impressible, others, e.g. pottery and water, are not. […] Those impressibles that retain the shape impressed on them and are easily moulded by the hand are called "plastic"; those that are not easily moulded, such as stone or wood, or are easily moulded but do not retain the shape impressed, like wool or a sponge, are not plastic. The last group are said to be "squeezable".
>
> (Book IV, part 9: Webster, 1923)

In another work, *On Memory and Reminiscence*, Aristotle offers the example of "running water", on which no form could be implanted, as a case of a material too fluid to be considered "plastic" (2014).

Plasticity belongs, therefore, in this intermediate space between ability to change and capacity to retain a shape, "between the opposing moments of total immobility and vacuity", fixedness and dissolution (Malabou, 2005: 12). It often overlaps with the apparently opposite notion of *robustness* (insensitivity to environmental changes), which is part of the same gradual continuum (Bateson and Gluckman, 2011). These semantic tensions, as we shall see, are inherent in the definition of plasticity and have not gone away in contemporary debates.

The modern historical trajectory of the term also presents a number of traps. From Aristotle's definition to Herder's eighteenth-century book *Plastik* (on plastic arts like sculpture) (1778 [2002]), plasticity belongs to the realm of inanimate matter, not living organisms. I will explore in the next pages a rare exception to this, in Renaissance embryological debates around the Neoplatonic notion of a *vis plastica* (plastic power: Smith, 2006; Hirai, 2007a). However, albeit not exclusive, the non-biological sense of plasticity remained predominant until Herder's time, when the term started to significantly increase in all the many European languages.[4] Besides re-elaborating some of the Greek themes about giving and receiving forms, Herder's book adds a further twist to the meanings associated with plasticity. He uses the term in a strong polemic against the modern primacy of sight versus touch, painting versus sculpture. While sight has a destructive function, to transform everything "into planes and surfaces", plastic arts like sculpture create an experience of the in-depth, of a three-dimensional body (1778 [2002]). Plastic is here the opposite not of fixed, but of flat, superficial, two-dimensional. So far, plasticity is not associated with modernistic ideas of continuous change, regeneration, tractability, improvement, or optimization.[5]

This is, instead, the meaning that plasticity would gradually acquire when it was imported since the nineteenth century into the biological and medical sciences. Here it was used to convey the idea of adaptability to environmental changes and, in medicine and neuroscience, renewal of tissues, memory formation, creation of new brain structures and potentiation of synaptic strengths (Stahnisch, 2003; Berlucchi and Buchtel, 2008; Overgaard and Jensen, 2012).

At the turn of the twentieth century, in the evolutionary writings of James Mark Baldwin, plasticity became a principle above natural selection to explain the evolution of intelligence and learning (Baldwin, 1902; Weber and Depew, 2003). Baldwin made plasticity a keystone of advancement toward higher stages of life (Spencer, a generation before, actually did the same, often with a racialist tinge). He posited that a correlation between

> increasing plasticity of the nervous system and increasing mental endowment holds as we ascend from a lower to a higher stage [in the scale of life].
>
> (1902: 36)

This association of plasticity with progress is even clearer in the work of another psychologist, Pavlov. In his 1930s neurological writings, Pavlov

described the higher nervous system as plastic, because of its "immense possibilities" and endless capacity to change. In plasticity, he claimed,

> nothing remains stationary, unyielding and everything could always be attained, all could be changed for the better, were only the appropriate conditions realized.
>
> (1932: 127, cited in Weidman, 2006: 79; see Todes, 2014: 524)

It is this utopian sense that we still find today in claims of "irreducible openness" of the plastic brain (Rees, 2016). What we can here notice is that, from this point onwards, the new plasticity of modern biology left behind the original meaning of plasticity in the sciences of matter. This latter implied a process of irreversible loss of possibility and inability to recover an initial form (Malabou, 2005: 34). In sculpture, plastic art *par excellence*, the immense potentialities of a block of marble or a piece of wood are irrevocably transformed into a statue: once the material has been shaped and carved, and of all the possible figures only one has been crystallized into its final form, there is no way back. The statue can be destroyed, but it cannot be undone, un-formed and restored to its original state.

There is nothing wrong or surprising in the fact that a scientific term accumulates a number of often opposing meanings along its trajectory through different vocabularies and paradigms (Canguilhem, 1955). But it is sociologically significant to highlight the crystallization of values between plasticity, potential for change, educability and progress during the course of the twentieth century. It is significant because it blinds us to the reality that emerging models of biological life may represent a departure from this one-sided view of plasticity, pointing instead to a less teleological and more complex, if not darker, meaning.

The dialectic of plasticity in contemporary social life

Outside of the life sciences, human plasticity has often remained the province of biological anthropologists, very far from sociological radars. However, things may be rapidly changing, given the widespread usage of the term to describe both processes of corporeal modification and biological embedding of social exposures that often come in socially stratified ways (Pitts-Taylor, 2016). It is enough to quickly scan a number of popular science books to realize that the social circulation of claims about the plasticity of the brain and the body becomes more visible by the day. These stories, however, are

not neutral or homogeneous. They are often divided into two very different strands that nicely capture the subtle paradoxes of plasticity. When it comes to the possibility of successfully manipulating our brain, genome, or microbiota to become a better us (better mood, better health and better mind), plasticity is mostly sold to a global middle class as a rosy message of individual control and optimization of function. It highlights how we can "train" and regenerate our brain and now our genomic expression through meditation, healthy diet, or exercise (Doidge, 2008; Shenk, 2010; Reynolds, 2014; Douglas, 2015; Le Doux, 2015). It builds on and expands an ideology of individual consumption and personal freedom deployed in the service of neoliberal and marketized models of health. Its popular versions emphasize choice, control and reversibility. It is possible today, we are told, to stimulate "new brain cells and networks where and when we need them" as well as to turn "genes off and on at will to repair brain damage, restore function, and optimize performance" (Horstman 2010: 8). In other popular accounts, epigenetics is described as offering hope that everyone can become a genius (Shenk, 2010), challenging the hard truth of a genetic basis for IQ as in past sociobiological accounts. This is the perfect version of biological plasticity for a culture where "care of the self is always about self-improvement, enhancement, and becoming something better" (Jones, 2008; Berkowitz, 2017: 33).

However, this is not the only phenomenology of plasticity that exists, though it is the one that has been most studied by sociologists (Papadopoulos, 2011; Rose and Abi-Rached, 2013; Pitts-Taylor, 2016; Berkowitz, 2017). A different, darker and more viscous plasticity, one that highlights irreversibility and loss of control, relates not to individual consumers but to vulnerable populations in Euro-America and increasingly more the Global South.[6] If plasticity lies in a paradoxical mid-way between the power to shape and the susceptibility to receive forms, it is vulnerable human groups, rather than individual consumers, that take upon them this second meaning: the *burden of plasticity*, that is, being sculpted by overwhelming social forces *beyond their control*. This is where plasticity should sound familiar to sociologists: it describes not only a faculty available to an individual agent (a habit that is a "possession" or a "disposition," as in the Latin and Greek etymology) but a power of transmission of social structures through embodied dispositions and practices. This is closer to ideas of modes of reproduction, inheritance and habitus in Bourdieu's term, something that cuts across a dualism of structure and agency, community and individual body (Bourdieu and Passeron, 1979; Bourdieu, 1986; Crossley, 2013). Its contemporary rephrasing as *biohabitus* (Warin et al., 2015) is probably even more pertinent to describe

the entanglement of biological and social environments that is at stake with emerging models of biosocial life.

Contemporary analyses of biosocial plasticity are very close to this sociological insight about a non-individualistic reproduction of social life. They don't see a chasm between individual and social bodies, and don't understand biological factors as operating within the skin of the individual, as fixed at birth, or as socially insensitive to the effects of social structures. Quite the opposite. Even Bourdieu's notion of capital is explicitly mobilized and expanded to cover new areas (for instance "maternal capital") in an effort to "facilitate integration" between sociological and biological explanations (Wells, 2010).

However, these models of human plasticity understand the reproduction of biosocial life in a specific way. Whether it is the lasting legacy of child abuse (Cecil et al., 2016), racial violence or antenatal depression in post-apartheid South Africa (Redinger et al., 2017), the incidence of diabetes in urban India (Gluckman and Hanson, 2012), the Aboriginal health gap and transgenerational trauma in Australia (Berger et al., 2017), the everyday effects of racism (Kuzawa and Sweet, 2009), or the long-term ones of slavery for Black Americans (Jasienska, 2009), environmental effects deemed to make a visible impression on bodies and brains are seen mostly in negative terms: pollutants, malnutrition or overnutrition, violence and trauma. Sometimes these effects are even seen to travel across generations. A biology sculpted by environmental events appears mostly in its pathological dimension. This is probably the most visible contrast with earlier studies of human plasticity that referred (mostly) to the positive effects of favourable environments on the bodies of immigrants.

The connection between plasticity and progress seems less visible in emerging biosocial models. These are not just some gloomy findings on the powerful effects of environmental insults, though. With the understanding of this special porosity of human biology and its susceptibility to possible damage from the environment, an *anxious vigilance emerges*. If our bodies are permeable to their genomic core, should we not monitor people's lifestyles more carefully than ever (Wastell and White, 2017)? And which people in particular? Not all bodies are considered equally permeable. If it is in the womb that many epigenetic effects are "programmed", should intensified attention and obligations be placed on pregnant women (Warin, 2012; Richardson et al., 2014; Mansfield, 2017)? Should they be monitored even before conception (for a wider reading of pre-pregnancy care: Waggoner, 2017)?

Consider the theory of the developmental origins of health and disease (DOHaD) or "foetal programming" (Gluckman and Hanson, 2005). DOHaD

originates from the work of British physician David Barker, who brought to attention the long-term health effects (cardiovascular disease, diabetes) of events occurring in critical moments of fetal development. The notion was far from new, but Barker was an enthusiastic propagator and a catalyst for the idea (the "Barker Hypothesis") that many chronic diseases in adult life have intra-uterine roots (Almond and Currie, 2011; Warin et al., 2015). Initial fetal programming studies focused on epidemiological statistical correlations between "conditions of early-life and later-life health in historical cohorts in British public records and turned them into clinical and experimental physiological problems" (Buklijas, 2018: 180; Adair and Prentice, 2004). These studies, originally labelled "foetal origins of adult disease" (Hales and Barker, 1992; Barker, 1995; Paul, 2010), mostly focus on the negative effects of *in utero* events (pollutants, stress, over or under nutrition, smoking) in increasing the risk of non-communicable disease later in life.

Interestingly, with their findings translated in related campaigns such as *The First 1,000 Days* (Pentecost, 2018), DOHaD studies in the Global South are making their way to the forefront of works in developmental plasticity. Since its founding meeting in Mumbai in 1990, DOHaD has always had a Southern focus (Pentecost, 2018), but this has become more visible in the last years. It is the case of economically emerging regions (such as India or China) that are undergoing dramatic nutrition transition (adoption of Western diet) and are characterized by cyclical patterns of intergenerational metabolic and coronary disease (Yajnik, 2001; Adair and Prentice, 2004; Watson et al., 2017). India, in particular, is home of the Pune Maternal Nutritional Study, which has gained international status as an explanatory model for long-term developmental effects of maternal undernutrition on diabetes epidemics in several Southern countries (Krishnaveni and Yajnik, 2017). The so-called "thin–fat" Indian baby syndrome – how Indian babies are "thin morphologically but metabolically obese according to [their] impaired insulin sensitivity and elevated levels of lipids" (Solomon, 2016: 22; Yajnik, 2004) – has come to popularly represent the notions of an epigenetic (developmental) origin, as opposed to a genetic origin.

Not only is the importation of Western diet at stake in these emerging studies in the Global South. It is also the case of poorer areas where DOHaD-related studies investigate the lasting effects of war, genocide and famine in hindering social and economic growth: studies have investigated the transgenerational transmission of stress via epigenetic mechanisms in women exposed during pregnancy to the Tutsi genocide or the long-term effects of nutrient restriction on offspring growth in rural Gambia (Perroud et al., 2014; Norris and Richter, 2016; Dasgupta, 2017; Eriksen et al., 2017).

Economists are also coming to use these developmental studies of shocks in human populations. Awareness of the long-term effects of plasticity has inspired recent macro-economic analyses of the "developing world" that recommend investments during critical windows of plasticity (pregnancy and early childhood) in an effort to foster economic growth and improve human capital. An emerging body of literature in health economics, which includes also influential economists like Nobel Prize winner James Heckman (2012), asks: "what if the nine months *in utero* are one of the most critical periods in a person's life, shaping future abilities and health trajectories – and thereby the likely path of earnings?" (Almond and Currie, 2011: 1; Almond et al., 2012). In this new operationalization of plasticity, "economics goes into the womb not only under the skin" (Wastell and White, 2017) – particularly the wombs of those living in "developing regions" (Currie and Vogl, 2013), or exposed to systematic stressors in "developed" ones. Drawing on plasticity rather than genetic fixedness, a new biopolitical management of vulnerable populations is emerging.

A genealogy of plastic power

In order to understand the polysemic meaning of plasticity as referring to both control and loss of control, capacity to remake oneself at will and realizing one's vulnerability to overwhelming forces in the near past and the present, reversibility and irreversibility, I suggest in this book an exercise in genealogical thought. Rather than address directly emerging forms of biopower and governmentality based on plasticity and related epigenetic notions, I prefer to take a longer genealogical perspective and show the complexity of the sociological discourses associated with the government of corporeal plasticity in ancient and early modern times.

In the specific meaning conferred on it first by Nietzsche and later by Foucault, a genealogical analysis connects "untimely" histories (Nietzsche, 1873/1997) to reveal complex filiations and struggles among competing epistemic paradigms (Foucault, 2003; Koopman, 2013).

Genealogy is an eminently sociological task (Rose, 1996; Greco, 1998; Diedrich, 2005) for showing the social and interactive nature of what is often taken for granted in narrow presentist interpretations (Aspers, 2007). It is a form of history of the present that examines the conditions under which certain powers and practices come into being. As such, it contributes to a problematization of historical sedimentations that obscure the contingency of the present social and intellectual order (Dean, 2003), and may build stimulating bridges

with various areas of sociological research, including historical sociology. This disclosing task of genealogy is well summed up by social theorist Ed Cohen:

> Genealogy's basic premise holds that the world is much more virtual and much more mutable than it presents itself. In genealogy we disclose contingencies secreted within phenomena which propose themselves to us as the essential dimensions of our world. Through this disclosure, genealogy hopes to glimpse instabilities where we often see inevitabilities, to imagine possibilities where we resign ourselves to necessities, and thus to learn to think and live otherwise than we supposed imaginable heretofore.
>
> (2009: 23)

My genealogical approach to contemporary plasticity builds on Foucauldian archaeology. Archaeology aims at describing discursive practices and epistemic formations while abandoning neat normative distinctions between subjected and authorized knowledge (Chimisso, 2003). Albeit it is often believed that genealogy replaces archaeology, it is more correct to say that, in Foucault, genealogy supplements archaeology. Foucault's endeavour can therefore be properly described as an "archaeological-and-genealogical inquiry into the emergence into being of related vectors of knowledge, power, and ethics" (Koopman, 2013: 44).

In this book, I follow a Foucauldian strategy to challenge the naïve and Eurocentric notion that plasticity has, until today, been silenced, pacified and marginalized in favour of a biology of fixedness; that fixedness has prevailed for centuries with its neat distinction between the interior of the body and the outer environment, and hence between nature and nurture; that plasticity is somehow a late gift of modernity, the effect of incremental scientific advance that has overthrown a centuries-long metaphysics of fixedness; and that only under a fixed view of biology do racism, eugenics and biological determinism became possible, with all of their enormous political consequences. Many of these assumptions do not withstand further examination. Perhaps more importantly, genealogy helps displace the notion that plasticity is a unitary phenomenon, coming in the abstract. It helps illuminate the unequal distribution of different forms of plasticities across social, gender and ethnic groups – inequality that alters the risks individuals face, the responsibilities imputed to them, and the interventions to which they may be subject. Genealogy serves as a healthy reminder that histories of corporeal plasticity have always been highly gendered, racialized and classed, mapping and reproducing hierarchies through physiological distinctions (Paster, 1993). Rather than

being inherently liberating, as many think, plasticity is ambiguously situated between making and unmaking essentialist notions of class, gender and race. It can be used to promote post-racial views that get rid of racial essences or arguments that once again lock people to place, time and the burden of experience. Racialization in science is not a matter of choosing plastic over fixed biology, epigenetics over genetics.

Plasticity and its troubled history: When we were plastic and how we forgot it

The possibility of a genealogy of plasticity seems to fly in the face of what many disciplinary chronologies in the life sciences tell us: that biological plasticity is a recent invention based on the discovery of some properties in our cells or neurons that were previously overlooked by constructions that emphasized stability and permanency. We are led to believe that an original metaphysics of fixedness in Western views of the body has been followed by a perception of plasticity driven by recent innovative research programs. Certainly, this narrative is mostly valid for various local branches of the life sciences (cell differentiation and culture: Landecker, 2007, see also Kraft and Rubin, 2016; neuroplasticity: Berlucchi and Buchtel, 2008; Rose and Abi-Rached, 2013; Rees, 2016; and plant biology: Baranski and Peirson, 2015). However, it does not hold true when we think of whole-body plasticity and notions like race or heredity. When extended to these wider aspects of human biology, it would be more correct to say that *generalized plasticity preceded fixedness*. If we define plasticity as above – the capacity of an organism to change in response to an environmental change (West-Eberhard, 2003) – the experience of plasticity is literally everywhere in ancient, early modern and non-Western understandings of the body.[7] As any historian of medicine knows, the belief in malleability of traits, and a continuous capacity to adjust the human body to a change in place, winds or food, was largely predominant before the rise of the modern biomedical body. This plasticity of traits may still be today the signature of a certain Southern understanding of human biology (Anderson, 2014).

It is particularly through humoralism and its global ramifications that the biopolitical problem of how to live with a permeable body became pervasive in premodern times. Humoralism, the doctrine that the body is composed of elementary fluids (humours) whose balance was altered by changes in the surrounding environment, implies a view of the body as radically embedded in places (Rosenberg, 2012). Bodies are "characterized by a constant exchange

between inside and outside, by fluxes and flows" (Nash, 2006: 32); they are, to paraphrase Deleuze, "made of contracted water, earth, light and air" (1994: 73). A fluid body, however, is also one that requires intense vigilance and control. Moreover, humoralist authors applied this basic instability of bodily traits to wider biological phenomena, including reproduction and what we call today heredity. Even the notion of the inheritance of acquired characteristics, and the interplay of nurture and nature in shaping heredity, attributed to Lamarck, is actually clearly part of the humoralist imagination, for instance in the Hippocratic *On Airs, Waters, and Places*, a key text of Greek humoralism (Chapter 2).

Ancient plasticity is not exhausted by humoralism, however. It is more accurate to say that in the premodern world, humoralism worked as a catalyst for a vast number of tropes about corporeal and racial plasticity that went well beyond its language and were widespread from the Greek to the Arabic and Indian world. Humoralism was just one among many possible views of corporeal plasticity and biological impressionability in medicine, philosophy and geography. Take, for instance, the notion that racial traits were directly shaped by environmental factors, the sun or cold, food or stars. Theories of racial malleability were used to explain ethnic diversity in the ancient world. Often combined with a strong moralistic flavour (Livingstone, 1991), they condemned whole human groups to inferiority because of the unfavourable environment they were shaped by or, more subtly, by claiming that their placement in particularly unfavourable places was a sign of their subordinate nature. In the pseudo-Aristotelian *Problemata*, after a connection is made between the excesses of climate and brutality of character, we read that "the Ethiopians and the Egyptians" are "bandy-legged", possibly because "their bodies become distorted by heat, like logs of wood when they become dry". "The condition of their hair", the author claims, in an obvious moralistic use of geography, "supports this theory; for it is curlier than that of other nations, and curliness is as it were crookedness of the hair" (book IV: "Problems connected with the effect of locality on temperament"; see Foster, 1927: 902). Other notions were less moralistic but not less important. Take, for instance, the role of the moon in shaping the morphology and inner nature of earthly bodies. Soranus of Ephesus, the author of the most important gynaecological treatise of the second century CE, notes the shrinking of a mouse's liver lobes with the waning of the moon; the Roman writer Pliny the Elder (CE 23–79), in his encyclopaedic *Historia Naturalis*, highlights the growth of shellfish with its waxing. Pliny writes that "it is certain also, that the Bodies of Oysters, Mussels, Cockles, and all Shell-fishes, grow and waste by the Power of the Moon". He also states that "in the small liver of the mouse the number of lobes corresponds

to the day of the moon" (Pliny, 1991: book I, 41 and book II, 76; cfr. Barton, 1994). Although many considered Pliny's treatise the source of naïve beliefs in ancient times,[8] Pliny, in fact, can be seen as part of a centuries-long tradition of belief in lunar effects. These views were still recognized as true in the mid-seventeenth century by the English royal physician Walter Charleton,

> who in 1654 explained that shellfish grew larger at full moon, perhaps because of the "Moon's great Humidity" developed from the lunar seas, "as the most and best of our Modern Astronomers have believed".
>
> (Schaffer, 2010: 159; see also Harrison, 2000)

A few years later, the German (or Dutch) anatomist Dirk Kerckring noted in his influential *Spicilegium anatomicum* (1670) the story of

> a young gentlewoman whose beauty depended upon the lunar force, insomuch that at full moon she was plump and very handsome, but in the decrease of the planet so wan and ill-favoured that she was ashamed to go abroad.
>
> (cited in Schaffer, 2010: 159)

The power of the moon was extremely important in the ancient and early modern world. Generally speaking, the logic was that, as the queen of heaven, the moon ruled over the fluids in the sublunary world (the part of the cosmos opposed to heaven, according to Aristotelian cosmology). Below the heavens, whatever is of watery nature will be affected by the moon's movements. Several centuries after Pliny, Albert the Great (1200–1280) wrote that it was "especially the eyes, in whose composition water's nature abounds", that "receive the greatest alterations and increases and diminutions according to the moon" (Resnick and Albertus Magnus, 2010: 53). The opinion was shared by other key scholastic thinkers in Latin West. Robert Grosseteste (1175–1253), bishop of Lincoln, had explicitly linked lunar movements to brain alterations. Since we know

> "by experience that, of all the heavenly substances, the moon exercises the greatest control over moist and cold bodies" Grosseteste wrote, "certain people are called lunatics because, when the moon wanes, *they suffer a diminution of the cerebrum*, since the cerebrum is a cold and moist substance".
>
> (Dales and Grosseteste, 1966: 461, my emphasis; see also Laird, 1990).

The special influence of lunar and solar rays on health and disease was a key theme of Arabic medical astrology (iatromathematics) from the eighth century onward (Meyerhof, 1931; Klein-Franke, 1984; Siddiqui, 1996; Saif, 2017). It continued as a respectable medical theory in the West well into the eighteenth century, as seen, for instance, in Richard Mead's *Of the Power and Influence of the Sun and Moon on Humane Bodies* (1708) (Harrison, 2000; cfr. Roos, 2000) and even later with Erasmus Darwin's Zoonomia (1794–96).[9]

Plasticity before plasticity: A longer history

By assembling these disparate bodies of knowledge about "ancient plasticity", I do not mean to suggest that people have long understood its molecular mechanisms and evolutionary significance, or that Grosseteste's passage can be used to date back neuroplasticity to Latin scholasticism of the thirteenth century. I am not looking here for a theory of predecessors, and I do not want to reify past traditions and practices of the body as a finished package of ideas or a stable referent that can immediately speak to our present concerns. I agree that the current understanding of plasticity is indeed a product of recent discoveries in neuroscience and molecular biology, made possible once scientists began to discard late nineteenth- and early twentieth-century notions of stability and permanency. However, a deeper and more pluralistic history of how living organisms were understood demonstrates that corporeal plasticity is not an event enabled by the linear unfolding of scientific innovation. Rather, a range of discourses, practices and ethical visions have stubbornly persisted and resurface today in the hype, potential and anxiety surrounding plasticity. A fresh, de-ossified approach to past counter-traditions and even forms of disqualified knowledge and anti-science (Foucault, 2003) suggests that the present has not been reached teleologically. A chief aim of this book is to show that the past is never entirely displaced, thus complicating the supposedly clean points of rupture in historical epistemology (Rheinberger, 2010; Loison, 2016). The postgenomic moment with all its scientific controversies exemplifies the contingency and precariousness of perceived epistemic closure. It uncannily overlaps ancient and very modern statements on the permeability of bodies to surrounding conditions. It undermines and provincializes ideas of a supposedly monolithic Western thought based on notions of stability and insuperable human–nature dualism, a cherished mythology for postmodernist and posthumanist authors.

A different family album for the epigenetic body

This applies also to the case of epigenetics, which I will describe in detail in Chapters 4 and 5. Through my pre-history of the plastic body I aim to reframe the current rise of interest in epigenetics within a broader history of body–world configurations. Usually, the most common origin stories of epigenetics cite Conrad H. Waddington's causal analysis of cell differentiation during development as its starting point (Waddington, 1957, 1968; Peterson, 2017; Squier, 2017; Buklijas, 2018). In more radical cases, epigenetics can be dated back to the early nineteenth-century theories of Jean-Baptiste Lamarck (Gissis and Jablonka, 2011) or the experiments of interwar heretic biologist Paul Kammerer (Taschwer, 2016). These links are accurate accounts in terms of molecular mechanisms and evolutionary debates. However, sociologically speaking, there is more to the present resurgence of interest in epigenetics than just Waddington or Lamarck. If we look at epigenetics as a contemporary template for a certain plasticity of the body; if we think of an epigenetic body as continuously metabolizing its surroundings, penetrated by multiple influences; if we think of epigenetics as a proxy for a certain malleability of heredity that extends beyond birth; if we think of race not as a fixed essence but as the embodied accumulation of environmental exposures; if we look at developmental origins of health and disease (DOHaD) as resurrecting a view of pregnancy as no longer a passive biological state but a moment of acute permeability requiring a permanent regime of vigilance; then none of the above claims look new or exceptional, and epigenetic and related postgenomic views of plasticity have a much deeper history to excavate.

I recognize that connecting the genealogical tree of epigenetics to ancient and early modern views of the body, such as humoralism, rather than twentieth-century explorations in embryology or molecular biology, goes against the grain of mainstream views. However, I am persuaded that this longer reading, even at the cost of losing some of the fine-grained quality of other approaches, presents multiple advantages, especially for a historical sociology of the body. Firstly, it offers a strong corrective to the present over-identification "with the temporal economy of innovation", where the appropriation and resurfacing of past themes is simply forgotten or denied (Cooper, 2017). Each age has its intellectual opium, and in contemporary life, innovation seems to be the winning one. In the Middle Ages, it was a point of honour to believe that ancient knowledge could not be surpassed. We seem to have made quite a radical inversion of this position, but no less uncritical. We simply make it a point of honour to ignore our past and overstate

the radicalism of our present so as to equate the innovatory with the valuable. In order to produce the current state of excitation and hype, the social imagination around biology must foreclose past histories of plasticity. In contemporary scholarship, active forgetting (Proctor and Schiebinger, 2008) and ignoring are the conditions of accumulating new intellectual capital.[10] Taking a longer view of the plastic body and looking at plasticity not as a riddle solved by contemporary Western science but as a ubiquitous belief in traditions predating and coexisting with modern medicine will help disabuse ourselves of the seeming radicalism of today's turn to permeability and the exceptionalism of Western findings. It will help us understand that we must look beyond segmented studies of history (the modernistic body) to recognize the long shadow cast over the present by the dispersed and complex roots of notions of corporeal plasticity.

Secondly, this genealogical approach helps conjoin twenty-first-century and earlier body–world configurations and epistemologies. It offers a unique opportunity to dislocate polarities between modernity and tradition, Western and Southern medicine, and hegemonic and subjugated bodies of knowledge, given the global ramifications of humoralism as a form of *plasticity before plasticity*. It does so by focusing not on the molecular mechanisms of plasticity, but on plasticity as a form of life, that is, a number of ethical questions and related *techniques of existence* about how to live with a permeable body and how to govern permeable populations with mutable racial traits. This allows us to problematize the utter separation between our modern science and body–world configurations based on ideas and practices of bodily fluidity particularly in the Global South (for India: Langford, 2002; South Africa: Dubow, 1995; Philippines: Anderson, 2006; Australia: Douglas and Ballard, 2008). This is a powerful antidote to the modernistic attitude of authors who "believe in epistemic ruptures so radical that nothing of that past survives in them" (Latour, 1993: 68). It is at the same time a key tool to problematize a "hypostasised" version of the West as absolutely other to "traditional cultures and histories" (Washbrook, 1997; Therborn, 2003). It is also important for developing a truly global study of science (Raj, 2013) that considers the non-Euro-American areas as site of knowledge production rather than of passive recipients of external expertise (Anderson, 2002). A global phenomenology of the body plastic before and aside the modernistic body of biomedicine can facilitate a more pluralistic study of science.

Thirdly, universalizing biological plasticity as a sort of default commitment contributes to *a provincialization* of biological fixity. This is of the utmost importance for a global sociology of the body. It enables us to raise questions

about the specific construction of the modernistic body of biomedicine as an exceptional sociocultural endeavour. If bodies have always been impressionable, heavily engraved by the power of external factors, how did we come to think of biological identity, heredity and race as immured from the external world? How did we come to think of ourselves as fixed and hardwired in genes? Rather than a generalizable case, biological fixedness (i.e. the genetic view of heredity), to paraphrase Walter Mignolo, is "a spectacular case of a global design built upon a local history" (2000: 22). However, as with every case of extraordinary intellectual success and hegemony, this intellectual prodigy needs a serious intellectual engagement and sociologically aware explanation. The implicit question behind this book is therefore to address the emergence not so much of current beliefs in plasticity as of those in fixity and hardness of bodies, race and heredity. How did a certain number of white, northern European men, mostly of Protestant background, come to equate biology with stability and lack of porousness since the last decades of the nineteenth century? Some of these men – Francis Galton, August Weismann, Ernst Mayr and Francis Crick – contributed to an insulation of the biological from its milieu and ideas of a hard nature writing at key junctures of political developments: the making of colonies and empires; nation-state building; the defeat of totalitarianism; and Cold War deployment. As others have noted, these wider biopolitical projects have framed and saturated the modernistic understanding of the biological body (Martin, 1994; Haraway, 1999; Cohen, 2009). As children of the twentieth century, we tend to believe that modernistic ideas of the immured body and insulated germ-plasm still offer the natural choreography of the relationship between the biological and the social, the fixed and the changeable. I don't mean to make these men – Galton, Weismann or Crick – the scapegoats of a cheap denunciation against modernism or individualism in biological theory. Their displacement of ideas of plastic bodies, races and heredity had, in several cases, an unquestionably emancipatory function (Meloni, 2016a). By highlighting how they worked against the grain of long-established views, I want instead to understand biological individualism, or perhaps biological liberalism, as a very fragile conceptual construct that may be already on retreat today (Gilbert et al., 2012; Bapteste and Dupré, 2013). Rather than being the default position, the notion of autonomy of the individual and disentanglement from environmental forces was achieved with great efforts in biological theory. Going through this history again may be particularly significant today, with claims of a new absorption of biology in its milieus again on the rise. It may also help provincialize emphatic claims of a vitality of matter, or intense traffic of body and milieu, that some postmodernist authors – unaware of this deeper history

and blinded by the belief in a monolithic ontology of fixedness that has never been there – hope to rescue in the interstices of a modernity that is more precarious than they can ever imagine.

An alternative genealogy of biopower

Genealogy is an essential tool in challenging universalizing narratives about plasticity (or lack thereof), as though there were a single and timeless human body. From a genealogical perspective, plasticity is less an ideal signification than the result of historically situated techniques for constructing and governing mutable and porous bodies. It is also the effect of some specific material phenomena and infrastructures, such as writing technologies, as I will claim later. Ancient and early modern plasticity was forged not in abstract philosophical discussions but in concrete biopolitical practices, medical investigations and classificatory techniques to hierarchically distinguish between sexes and among ethnic groups on the basis of their softness and vulnerability to the all-encompassing power of the environment. Through medical, philosophical and climatological cartographies, the differential plasticity of various populations was used to separate ruling from ruled groups, Europeans (Greeks and later Romans) from Asians, temperate countries from the tropics. This inaugurated a tradition that lasted well into nineteenth-century colonialism: plasticity of traits at the service of military conquest and imperial designs (Osborne, 2000), but also plasticity as fear of racial deterioration after migrations to the new colonies, and hence unknown food, stars and climates (Earle, 2012; cfr. Stoler, 1995; Anderson, 2016).

The ancient biopolitics of plasticity presents some recurring themes that are worth keeping in mind. One is the construction of Oriental populations as *softer*, *more delicate* and *unwarlike* because of the way they are shaped by the monotony or gentleness of their climate. This trope can be found, to different degrees, in Hippocrates' *On Airs, Waters and Places*, in Aristotle's *Politics* and in later Roman authors. The argument about Oriental lack of "manly courage (*andreion*)" was easily turned into a platform for imperial strategies (Kennedy, 2016) and theories of natural slavery (as in Aristotle's *Politics*, 7.7). In the Middle Ages, the influential historian Gerald of Wales (1147–1220) still relied on this delicacy of Eastern groups to suggest how to defeat them militarily (Irby, 2016). Noticeably, from the fifteenth century and the first global colonial invasions, a North–South axis based on *latitude* (Wey-Gómez, 2008) juxtaposed this predominant Orientalist construct to classify tropical populations as less capable of governing themselves and being free. Aristotle's *Politics* is a compendium of

all these ideas, with people living in temperate (*mediocriter*) places presented as the most capable of producing the best political systems:

> The nations inhabiting the cold places and those of Europe are full of spirit but somewhat deficient in intelligence and skill, so that they continue comparatively free, but lacking in political organization and capacity to rule their neighbours. The peoples of Asia on the other hand are intelligent and skilful in temperament, but lack spirit, so that they are in continuous subjection and slavery. *But the Greek race participates in both characters, just as it occupies the middle position geographically, for it is both spirited and intelligent; hence it continues to be free* and to have very good political institutions, and to be capable of ruling all mankind if it attains constitutional unity.
>
> (Pol. 1.327b23–33, my italics)

Views of direct environmental influence and the porosity of bodies to these effects also entered the military machines of ancient empires, like that of the Romans. Officers, such as Vegetius (*De re militari*, I/2), suggested avoiding recruiting troops from cold climates as they had too much blood and, hence, inadequate intelligence. Instead, he argued, troops from temperate climates should be recruited, as they possess just the right amount of blood, ensuring their fitness for camp discipline (Irby, 2016.). Delicate and effeminizing land was also to be abandoned as soon as possible, according to Manlius or Caesar (ibid.). Probably the most famous geopolitical dictum of antiquity reflects exactly this plastic power of places: "soft lands breed soft men", according to the claim that Herodotus attributed to Cyrus.

The strict relationship between geography and virtue is one of the most important biopolitical leitmotifs of ancient and early modern history, reaching scholastic philosophers such as Albert the Great and early modern political thinkers, including Bodin and Montesquieu. The moulding influence of geography produced various cartographies of racial and imperial domination based on soft, not hard, traits. While I will explore these and similar sites of ancient plasticity more systematically in the next chapter, my point here is that this oft-forgotten history matters to counter versions of biopower, colonial domination or racism as only being traceable to essentialist notions of fixity and innateness. This is a fundamental anachronism for ancient and early modern times. The supreme power of environmental effects was a key biopolitical dispositive of past and early modern authors. Environmental tropes of corporeal and racial plasticity were rarely used in a benign way. This is why we need to take a critical distance from the exquisitely twentieth-century notion of

environmental effects as "more imaginative, more rational and more humane" (Toynbee, 1934) than other forms of biopolitics and racism.

However, is it appropriate to speak of biopolitics regarding these widespread environmentalist tropes? Is this an anachronism? It is undoubtedly an anachronism, but so is the usage of the word in Foucault for eighteenth-century police science (Ojakangas, 2016a). It is not my ambition to challenge directly the Foucauldian idea that a true biopower starts from early modern absolutism, and is only partly anticipated by forms of Christian pastorate (Foucault, 2003), but indirectly, I think I offer good evidence to problematize this claim. In the light of the subtle complexity of managing physiological functions under a humoralist framework, I find it hard to claim, as Foucault does, that biological life has entered into "history" and the spheres of "political techniques" only "millennia" after the Greeks, at the threshold of modernity (1978: 141–142). I aim to complicate another claim in the light of humoralist techniques of the body (Chapter 2): that of a purportedly hard separation between bare and qualified life, *zoe* and *bios* (Agamben, 1998), according to which one can claim either that there was no contamination between corporeal processes and the political realm in ancient times (Arendt, 1958), or that an originally separated bare life was excluded in order to be assumed within the paradigm of power (Agamben, 1998). These (quite problematic) views of ancient life have been used to support the notion either that there is only one overarching paradigm in the history of biopower (Agamben, 1998)[11] or that there was no biopolitics or even politicization of biological matter in the Greek world (Foucault, 1978). In recent years, Mika Ojakangas has argued against this latter thesis and in favour of the legitimacy of the category of ancient biopolitics. He has claimed that notions of power in the Greek polis are connected to vital processes:

> Ancient Greek political thought does not revolve around laws, juridical persons, free wills, contracts, and obligations, but around the technologies of power over natural life whereby, to paraphrase Foucault, the basic biological features of the human species become the object of political strategy.
>
> (2016a: 141; see also 2016b)

I am sympathetic to this idea that there is a strange blindness in Foucault's reading of biopower in the Greek and Hellenistic world. However, unlike Ojakangas, my claim is that this story of ancient biopolitics is only partially captured by the writings of Plato and Aristotle. It is even less understandable by projecting onto Plato or Aristotle the traits of the authoritarian

pedagogy of early twentieth-century selectionist eugenics (Roper, 1913; Günther, 1928; see Forti, 2006). This version of biopower is not the one I aim to find with my analysis of the ancient and early modern body. Firstly, neither Plato nor Aristotle shared the view of racial purity or heredity of mainstream early twentieth-century selectionists (see Klosko, 1991). Both of them thought in a very different framework: open to the influence of nourishment upon heredity (Aristotle, *Pol.* 7.1336a3–5) or even to the inheritance of acquired characters (Plato, *Laws* 6.775d). They were definitely proto-racialist (Isaac, 2006), but in a sense quite different from our post-nineteenth-century view of race. However, besides the philological readings of Aristotle and Plato, I take issue with Ojakangas' interpretation because in focusing only on ancient philosophers, physiological bodies become conspicuously absent. Authors like Agamben and Ojakangas who support notions of ancient biopower miss the everyday physiological governance of bodies that can be found in sources like Hippocrates or early modern moral treatises on *the art of living* based on humoralist tropes. Here one can find more clearly the traits of an ancient governmentality of the body (individual but also collective) based on ideas of corporeal malleability, environmental influences and biosocial effects. This is a different, more horizontal form of biopolitics that impregnated day-to-day practices constructing ideas of personhood, corporeal management, and recognition of the body's vulnerability to its surroundings. Interestingly, this older history of a soft biopolitics may have some resonances with contemporary forms of neoliberal governmentality and the somatic individual (Rose, 2007). In particular, one of its key features stands out: the tension between targeting individual behaviours and making collective identities and hierarchies among human groups. Ancient and early modern views of the body, particularly but not only via humoralism, gave rise to initial forms of biopolitics at the level of both the political anatomy of the individual body and forms of government of populations. The former side has been highlighted particularly by Michael Schoenfeldt (1997): the porous humoralist body became the site for a quite specific art of self-fashioning, in which prudence, to cite Foucault, vigilance and a "constant and detailed problematization of the environment" were constantly reclaimed (Foucault, 1990: 101). Especially in the doctrine of the six non-naturals (Chapter 2), humoralism pushed people to enter into a certain relationship of self-governance and self-examination with their own body. It was, for this reason, easily incorporated into liberal and even bourgeois doctrines of individual health later in the eighteenth century

(Coleman, 1974). This was not an abstract view of the legal individual but a truly biosocial view in which shaping and controlling bodily fluids, vital processes, pores and metabolism with the external world was of the utmost importance. However, and this seems a blind spot in Foucault's analysis of ancient ethics, there was more than just individual techniques of the self in ancient bodies, more than just self-reflexivization. Humoralist, physiological and wider environmentalist tropes became the platform for vast technologies of power by which different groups and sexes were classified, and ultimately governed, on the bases of their specific physiology, permeability and corporeal fragility (Paster, 1993). Perhaps these strategies were not centralized, as in the eighteenth-century police science analyzed by Foucault. Nonetheless, they displayed that "double process" of subjectivation and objectivation by which the production of individual bodies "could also be described from the external perspective as a relationship of power" (Detel, 2005: 34). This silent shift away from individualization to the making up of biosocial collectives (racialized, gendered) appears very profound in the history of corporeal plasticity and may serve as a guiding thread to an alternative and longer history of biopower.

Importantly, this *longue durée* perspective may also contribute to a sociological history of the "civilizing process" that aims to explain the making of *homo clausus* (the separate, contained individual of modernity) not as a starting point but as the culmination of a long and conflicted historical process (Elias, 2000). Unlike Elias, however, a focus on humoralism disconnects the emergence of practices of the self (exclusively) from the making of the absolutist state in sixteenth-century Europe. It also challenges the Eliasian notions that these disciplinary techniques were mostly based on a repression of bodily fluids and evacuations. Humoralism gave rise to a more complex and sophisticated body–world configuration than this repressive hypothesis would have (Paster, 1993).

Embedding plasticity in a material history: Plasticity and sexual difference

If we think of corporeal plasticity as a last-minute invention without recognizing the complex filiation of contemporary notions and practices, we risk missing its present ambiguity and silencing its inherently political moment. We may overlook the idea that contemporary plasticity enables, at the collective level, forms of gender and racial domination that go well beyond depoliticized

individual consumerism. The contemporary sociology and anthropology of plasticity very often avoid this historical depth and genealogical awareness. Plasticity is either celebrated as an ethical epiphany where a "whole new figure of the neurological human emerged" (Rees, 2016: 278) or dismissed as a trick of "neoliberal pressures of self-care, personal responsibility, and constant flexibility" (Pitts-Taylor, 2010: 640). Both these alternatives are unsatisfactory. They are modernistic assumptions (from the Latin *modo*, "just now"; see Cohen, 2009) that ignore the sedimented histories that precede and inform current body–world configurations, which may unfold again. The biopolitical shadow of past usages of plasticity is elided, in all its complexity and subtlety, and with that the material dispositive in which ancient plasticity was devised and conceived.

The exception to this modernistic understanding of plasticity is Catherine Malabou's work (particularly 2005). Uniquely among contemporary social commentators, Malabou has written important pages that trace plasticity back to its original Greek moment. She has particularly highlighted Aristotle's key text *De Anima* as a source (via Hegel) of modern debates on plasticity and its influence on anthropology. In *De Anima*, Malabou claims, the notion of "noetic plasticity" emerges as a profoundly duplex notion: "the originary unity of *acting* and *being acted upon*, of spontaneity and receptivity" (2005: 186). Following Malabou's analysis is very helpful: we are still very much caught in this oscillation between agency and vulnerability, making and undergoing that, according to Malabou, exemplifies the Greek experience of plasticity (ibid.,: 40). However, Malabou's reading reflects an idealized view of plasticity that remains unsatisfactory from a genealogical viewpoint. It obscures the embedment of Aristotle's work in a number of highly gendered metaphors from which plasticity emerges in sublimated terms. This is where a historical sociology of plasticity, which looks at its socio-material infrastructures, may work as a corrective to idealized philosophical readings.

The Aristotelian *De Anima* is, as commentators have observed, as much a philosophical treatise as a biological one (Shiffman, 2011). If one reads the notion of noetic plasticity against the wider background of the Aristotelian corpus, and particularly his patriarchal view of sexual reproduction, it will appear very clearly that the dual economy of plasticity – the interplay of *moulding* and *being moulded* – is embedded in a profoundly gendered imagination. Famously, in another work, the *Generation of Animals*, Aristotle establishes his masculinist view of embryogenesis based on the fundamental opposition between the male "as the active producer [*poiētikon*] and mover" and the female "as passive [*pathētikon*] and moved" (*Generation of Animals*, I.21 729b15–18; cited from Bianchi, 2014: 54). In this patriarchal view of biological growth and sexual difference, male and female are distinguished by

the fact that the former possesses a certain power/capacity to give form that the woman lacks. This reflects the basic idea for Aristotle that

> the semen of the male differs from the corresponding secretion of the female in that it *contains a principle* within itself of such a kind as to set up movements also in the embryo and to concoct thoroughly the ultimate nourishment, whereas the secretion of the female contains material alone.
>
> (*Generation of Animals*, IV.1, my italics)

This principle (or the "efficient cause of generation") is in fact originally a formative force: the vital heat (*pneuma*) possessed by the male semen that has the power (*dynamis*) to shape forms during generation. The menstrual blood of the female (*menses* or *catamenia*) is instead cold and, hence, deprived of formative power. "The menses are seed but not pure seed", Aristotle writes, "for it lacks one thing only, the source of the soul". Menses contains the inert material of generation and can only receive forms (*Generation of Animals*, books II and IV, in particular 768 b15–27).[12] Aristotle's *Generation of Animals*, as philosopher Emanuela Bianchi writes, is "the hidden and therefore never adequately studied foundational book of Western patriarchal metaphysics" (2014: 3).

Plasticity's inherent dualism of both "to fashion and to be fashioned" (Malabou, 2005: 40) looks much less mysterious if one places Aristotle upon his biological and sociological feet, in the context of ancient forms of gender domination. The two sides of plasticity, the power to shape and the vulnerability to receive forms, can be allocated to the paternal and the maternal causes, respectively, in embryogenetic processes. The father will historically take the first side of plasticity: an active power that is the generator of forms, a "maker". Interestingly, Aristotle makes an explicit analogy between the male semen and a sculpting power, as something that can puts things into form, as in a "work of art" (GA II. 4). The female embodies the second sense of plasticity: a passive substrate upon which formative power is exerted. This second sense of plasticity is nicely captured by Joseph Needham's comment on Aristotle's embryogenesis, when he writes that the "male dynamic element […] gives a shape to the *plastic* female element" (1959: 43). Female plasticity is no longer the power to generate but just to absorb alien forms. That this embryological background is one of the keys to a genealogy of plasticity finds further confirmation in the trajectory of the notion of "plastic power" or *vis plastica*, which became very influential in Renaissance debates (Hunter, 1950; Hirai, 2005 and 2016; Smith, 2006). *Vis plastica* can be traced back to embryological debates (mostly in Galen) where the active power of the paternal semen (hotter than the female semen) is said to contain a special

moulding faculty: *dunamis diaplastike*, plastic power, because it moulds the inert female matter. This faculty, via the work of Arab commentators like Avicenna, will transit to the Renaissance, becoming a "divine formative power" (Fernel, 1548) or a "plastic", spermatic logos, as in Schegk's *On the Plastic Faculty of the Seed* (*De plastica seminis facultate*, 1580). Cambridge Platonists in the seventeenth century will then turn this idea into a notion of "plastick might" in the sense of a transcendent intellect pervading and shaping all physical processes, not just foetal development (Hirai, 2005; 2007a and b; 2017). This is the only visible 'biological' usage of the term "plasticity" before modernity. Its history betrays a very masculinist origin in the radical asymmetry between the formative power of the male seminal liquid and the maternal receptive matter.

The political materiality of plasticity: Impressionable biologies

This is just one possible example of the way in which a genealogical approach may help not only trace forgotten filiations of ancient plasticity but also re-embed its vocabulary into a very material history of gender and race domination. There is a second genealogical route to diffract ancient plasticity through the prism of its very material origin. This genealogical route inspires the title of this book and my whole project of defining biological matter as deeply imbued with social meanings, not just "malleable" but durably "impressionable". It comes directly from writing techniques in classical times: incising marks on wax tablets using a small pointed metal tool (*stilus*) or sealing a block of wax with a metal stamp to make official signatures in relief. This infrastructural aspect offered a key metaphorical repertoire by which Plato and Aristotle conveyed the idea of marking a receiving surface. Importantly, this process of imprinting is often rendered with the Latin term *impressio* [from *imprĭmo*, *in-* + *premō*: to press in]. It is through this metaphor, as we saw above, that Aristotle defines plastic matter as an "impressible" matter in his *Meteorology*. The process of making an impression, Aristotle says,

> is the sinking of a part of the surface of a thing in response to pressure or a blow, in general to contact. Such bodies are either soft, like wax, where part of the surface is depressed while the rest remains, or hard, like copper. Non-impressible bodies are either hard, like pottery (its surface does not give way and sink in), or liquid, like water (for though water does give way it is not in a part of it, for there is a reciprocal change of place of all its parts).
>
> (Book IV, part 9)

However, from this physics of plasticity, metaphors of impression are extended to much more complex models. Consider, for instance, two key passages in Plato and Aristotle, both translated by scholastic Latins with *impressio*. In the first, Plato famously compares the soul to "a block of wax" and the mechanism of memory to making "impressions from seal rings" upon it (*Theaetetus*, 191, c–e). In the second, Aristotle advances his influential theory of signification by comparing sense perception to "the way in which a piece of wax takes on the impress of a signet-ring without the iron or gold" (*De Anima*, II, XII). Here the Latin word *impressio* translates the Greek *sēmeion*, sign. One could extend these examples to the whole of antiquity, where metaphors of the soul or the body as written or impressed upon were common currency. However, the word *impressio* often took a stronger and cruder meaning beyond the description of a writing or sealing process. It overlaps with notions of *impetus*, *physical violence*, *assault*, *irruption*, *military attack*. This more violent sense is well retained in the Latin version of the Hippocratic treatise *On Head Wounds* (1999). Here, the text uses "impression" to refer to "the weapon which struck against the bone leaves its impression on the part which it struck" (part 7). Even more interestingly, at the intersection of writing mechanisms and physical pressures, *impressio* became, in the Scholastic tradition, a template for any form of "environmental" influences from heavenly bodies (*corpora caelestia*) onto inferior sublunary matter, including the Earth. This is, for instance, the sense in which it is used by Dante in his *Divine Comedy* when, describing the sun, he gives voice to Saint Thomas:

> Lo ministro maggior de la natura,
> che del valor del ciel lo mondo *imprenta*
> e col suo lume il tempo ne misura.
>
> *Commedia* III X 28–30 (my emphasis)[13]

Dante is simply reflecting here a widespread usage of metaphors of imprinting in scholastic times, from Albert the Great to Robert Grosseteste. This latter wrote in 1220 a treatise called *De Impressionibus Elementorum*, that is, *The Impressions of the Elements*. Thomas Aquinas (1225–1274) himself used the metaphor repeatedly. For instance, in his *Summa Theologica*, in an attempt to rescue free will from a too materialistic view of the imprinting powers of celestial bodies, he claims that "it is impossible for heavenly bodies *to make a direct impression* on the intellect and will". In so doing, however, he must concede that celestial bodies can "be a dispositive cause of an inclination to those operations *in so far as they make an impression* on the human body" (*Summa Theol*. II, II, 95 a 5; my emphasis). It is at this level that the widespread belief

in astrology in Latin scholasticism and early modernity can be understood as a part of a general theory of impression and bodily plasticity. Authors like Albertus the Great, or later Machiavelli and Ficino described via astrological themes (especially when it comes to electoral astrology, that is, the influence on the course of everyday actions, not what is fixed at birth) a particular malleability of either the individual or the body politic to celestial influences.[14]

Interestingly, this framework of a direct impression of the heavens on sublunary bodies is not gender neutral. Here we are brought back to the above point about plastic power and sexual difference. In Aristotle, several Arab commentators and the later scholastic tradition, the analogy between *celestial influences as a paternal power* and the *receptive sublunary matter as a female* is quite literal. Impressions, as plasticity, originate from a masculine power to shape female matter. As Justine Smith writes, citing the Dominican philosopher Antoine Goudin (1668):

> according to Aristotle and Saint Thomas, earth and water furnish to everything arising from the bowels of the earth their matter and bosom, as would a mother, while heaven and the stars fulfil the office of the father, who imparts the form. A "male" formative principle exercises its influence over the "maternal" matter of the earth and thereby gives rise to forms in earth that resemble living beings.
>
> (2013: 262)

The general impressionability of sublunary bodies is therefore an aspect of their feminine and susceptible nature. This recipient matter is shaped by the dispositions left "from the imprint of the active principle (*principii agentis*)", as medieval theologians used to say (Arens, 1984: 464).

It is finally worth noting that, besides this widely used sense of a celestial influence on the earth, impression is also the framework through which theories of corpuscular vision and hearing are explained by scholastic thinkers (Aquinas, 1951). Notions of impressions are used in epistemological debates (how truth impresses itself into concepts) and even Trinitarian theology (how the Holy Trinity impresses its triune character upon the angelic hierarchy in Bonaventure). More significantly for future debates on the impressionability of female matter, both sensory cognition and generation were often explained "in terms of the impression of the images on soft or subtle matter" (Park, 1998: 260). For this reason, they were seen "not only as cognate faculties but faculties whose operation was physiologically linked" (ibid: 260, 262); hence one of the sources of the pervasive beliefs in maternal impressions – the capacity of women to mark, imprint or deform the foetus through

"imagination" – which will represent one of the key pathways of plasticity until early modernity.

Overview of the book

The notion of impressionable biologies aptly condenses the original non-modern intuition of a body constantly exposed to an immense number of external influences. This was an attentive and excitable body, but also a body constantly *under pressure*, at the mercy of the all-encompassing power of the environment, physical and social, with profound patriarchal and racialist resonances. This vulnerable biological matter will be explored in the next chapter mostly through its most visible ancient and early modern champion, the humoralist body (Chapter 2). I will then discuss how this original plasticity and explanatory models based on the appeal of direct environmental influences had to be challenged by key nineteenth century authors in order to align the biological body to some key tenets of modern liberalism: *autonomy*, *inviolability* and *boundedness* of the individual body. I will focus on the contribution of Darwin and Weismann and the emerging views of heredity in genetics as quintessentially modernist strategies to displace ancient plasticity. They all broke with the "Hippocratic imagination" (Cohen, 2009) of a body circumfused by place. Darwin (at least for his selectionist thesis, given that his view of heredity is deeply "Hippocratic", i.e. pangenesis, as I will argue below) and Weismann produced conceptual technologies to subtract or buffer the individual from environmental pressures. This move included the breaking of ancestral ties to establish that individuals were born free, or at least unburdened by the actions of their immediate ancestors. After the rise of selectionism and later genetics, the environment was disentangled from the individual body, taking shape as a well-defined field of forces that one could look at externally, that is, as alien to an authentic and irreducible self. The radical plasticity and ecological inspiration of humoralism, a body of flows and liquid forces (Paster, 1993), including its most sinister versions (racial degeneration as a consequence of colonial migrations or environmental exposures), started to look increasingly problematic for late nineteenth century authors (Chapter 3). Chapter 3 is somehow a self-standing unit in the context of the book, but helpful to identify the moral implications of the nurture first/nature first debate that are resurfacing today in epigenetics.

In the third and final part I will discuss how epigenetics may open once again the door to a view of the permeable body in the language and framework of

twenty-first-century molecular biology. I read with interest and curiosity the emerging wave of epigenetic literature, and am sympathetic to many of its efforts to put this knowledge in the service of under-represented groups and communities (Chapter 4). My main concern, however, reflects the lesson I have learned from the history of the plastic body: *a body shaped from and traversed by outside matter is also a body vulnerable to a number of disciplinary practices and forces*, open, that is, to "governmental intensification" (Rose, 1996). Albeit it may seem old-fashioned to claim this nowadays, biological liberalism – with its art of separation and boundary-making (Walzer, 1984) – had kept these forces contained through a strong notion of individual autonomy and physiological insulation. This withdrawal of the individual body from the towering power of the external environment gained momentum in nineteenth-century biomedical thought also because it could be perceived as a technology of freedom. The question in the final chapter is therefore what happens in postgenomics as a post-liberal biological world in which the individual is submerged again by environmental forces at the molecular level. I focus in particular on the emergence of the complex figure of plasticity generated by epigenetics: a plasticity that is neither about modernistic control (that is, responding to the desire of an agent-master) nor about endless potentialities, as in postmodernist narratives of fluidity and decentering of the subject. Epigenetics' emerging plasticity is not explainable in the above terms; instead, it is closer to an *alter-modernistic* view that disrupts clear boundaries between openness and determination, individual and community. The resonance of this notion with older epistemologies of the body and non-Western ecological views may explain the growing interest and appeal of epigenetics in postcolonial areas beyond the mainstream scientific Global West, as I highlight in the final chapter (Chapter 5).

Notes

1 Postgenomics is usually taken as a temporal label, to reflect a period inaugurated with the completion of the human genome project in 2003. However, in my reading I will favour the notion that postgenomics is a different "style of reasoning" (Hacking, 2002) compared with genomics – one that emphasizes the permeability of the genome to material surroundings and the plasticity of its functioning. I will define the term and its history more extensively in Chapter 4.

2 Antonyms are not really "opposite". While opposition implies incompatibility (single/married), antonyms are gradable pairs whose meanings are oppositional along a continuum (such as dry/wet). Some authors in semantics take opposites also to be a kind of binary antonyms, so in this case plasticity and elasticity would be "gradable antonyms" (see Lyons, 1977).