

# Thinking about a Natural Contract: with Michel Serres (1930–2019)

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In the summer of 2019, the French mariner, philosopher and historian of science Michel Serres passed away. This essay is an homage to a great thinker and humanist of our days. In it, I focus on Serres' book *The Natural Contract*, with a short digression to his *Biogée*.<sup>1</sup> *The Natural Contract* was published in French in 1990,<sup>2</sup> more than thirty years ago, but it has lost nothing of its urgency—nor of its literary beauty. On the contrary, Serres was a pioneer of the Anthropocene before the term had come into use.

What follows is a close reading of a few passages documenting Serres' engagement with what we may call the five elements out there: earth, air, fire, water, and the world of the living. I will pay particular attention to the role attributed by him to the sciences in what he saw as the unavoidability of making peace with the planet—for the sake of our own survival. In order to cope with this actual, ever-increasing challenge, according to Serres, a new alliance is necessary between two types of reason: the reason behind what he called 'faithful knowledge', that is, the knowledge of the sciences about the material world, and the reason behind 'prudent judgment',<sup>3</sup> thus, between 'pure reason' and 'practical reason' according to the classical dichotomy of Kant's *Critiques*.<sup>4</sup> Whether we should talk about responsibility—of whom and to whom—in this matter, shall be briefly dealt with at the end of this essay.

## BEING IN THE WORLD

On October 17, 1989, the Loma Prieta earthquake shook the Bay Area of San Francisco with a magnitude of 6.9. At Stanford University in Palo Alto, Michel Serres was writing the last pages of his manuscript on *The Natural Contract*. Back then, he wrote into its last lines: 'Who am I, now, for several seconds? Earth herself. Both communing, in love she and I,

<sup>1</sup> Michel Serres, *The Natural Contract* (first published 1990, Elizabeth MacArthur and William Paulson tr, University of Michigan Press 1995); Michel Serres, *Biogée* (Editions Dialogues 2010).

<sup>2</sup> Michel Serres, *Le Contrat naturel* (François Bourin, 1990).

<sup>3</sup> Serres, *Natural Contract* (n 1) 93.

<sup>4</sup> Immanuel Kant, *Critique of Pure Reason* (first published 1781/1787, Werner S Pluhar tr, Hackett Publishing Company 1996); Immanuel Kant, *Critique of Practical Reason* (first published 1788, Werner S Pluhar tr, Hackett Publishing Company 2002).

doubly in distress, throbbing together, joined in a single aura.<sup>5</sup> Twenty years later, in his *Biogée*, he recalled this sentiment: ‘... on the Fault of San Andreas, ... I finally became a being-in-the-world’.<sup>6</sup>

The *Natural Contract* was published in the spring of 1990 in Paris and aroused a considerable storm of theoretical outrage. The scandal: how could a rational being dare to ascribe to nature the character of a contractual subject? Slightly less than ten years later, upon the invitation by the French National Library to look back on the publication of his book, Serres revisited its underlying rationale. There, he formulated it succinctly as follows: ‘The subject becomes object. We become victims of our victories, the passivity of our activities, *medical objects* of our actions as *subjects*. And the global object becomes the subject, for it reacts to our actions.’<sup>7</sup>

How right he was to call us ‘medical objects’ back then, as we have acutely been experiencing with the recent pandemic. In his text, Serres was claiming that humankind must abandon its *parasitic* relation to nature and convert it to a *symbiotic* relation. ‘Rights of symbiosis’, we read in *The Natural Contract*, ‘are defined by reciprocity: however much nature gives man, man must give that much back to nature, now a legal subject.’<sup>8</sup> But, he asks, ‘[w]hat language do the things of the world speak, that we might come to an understanding with them, contractually?’ and promptly answers: ‘In fact, the Earth speaks to us in terms of forces, bonds, and interactions, and that’s enough to make a contract.’<sup>9</sup> Eventually, it was an earthquake—of all the forces of nature, the one least subject to human manipulation—that led Serres to perceive a symbiosis with the earth as being an imminent inescapability.

On that October day, I happened to be sitting in a seminar room in the Program in History of Science, on the second floor of the Main Quad of the Stanford campus. The speaker—his name has been effaced from my memory, like all the other faces in the room—had just started to summarise his talk shortly after five o’clock.<sup>10</sup> The massive building began to shake like a nutshell, no chance to get down the stairs, we were lying flat on the ground. These thirty seconds appeared to last forever. But the building stood. The group got out, along with the snacks prepared for after the talk. Nobody said a word. Silently, we sat down on the lawn, in a circle, food in the middle, and began to eat.

## THE SYMBIOTIC PLANET

About ten years after the publication of *Le Contrat naturel*, another milestone concerning the state of the planet was published: *The Symbiotic Planet* by Lynn Margulis.<sup>11</sup> It was the *summa* of thirty years of research on evolutionary symbiosis by the American biologist. Serres could not yet have read this book when he lectured at the French National Library on January 14, 1998, but at that time, the endosymbiont theory of cellular evolution developed by Margulis was already widely accepted, and its academic presence had become ubiquitous. Serres does not mention Margulis in his book, but that does not mean much, for his entire book on *The Natural Contract* is written without a footnote and without references. We can safely assume that he was familiar with her theory. Serres had already referred to the

<sup>5</sup> Serres, *Natural Contract* (n 1) 124.

<sup>6</sup> Serres, *Biogée* (n 1) 38 (author’s translation).

<sup>7</sup> Michel Serres, *Retour au contrat naturel* (Bibliothèque Nationale de France 2000) 17 (emphasis in original).

<sup>8</sup> Serres, *Natural Contract* (n 1) 38.

<sup>9</sup> *ibid* 39.

<sup>10</sup> Naomi Oreskes, who also sat in the audience and happened to participate in the workshop in which this essay was presented, kindly reminded me that the speaker was Donald MacKenzie.

<sup>11</sup> Lynn Margulis, *The Symbiotic Planet: A New Look at Evolution* (Weidenfels and Nicoloson 1998).

metaphorology of biological relations in 1980 with his well-known book *The Parasite*, and Margulis is without doubt his biological reference with respect to the use of the term symbiosis.<sup>12</sup>

Margulis summarised her views with an evolutionary generalisation as follows: ‘Anastomosis’—that is, symbiotic as well as endosymbiotic fusion—‘although less frequent, is as important as branching.’<sup>13</sup> With that, Darwin’s principle of ‘divergence’,<sup>14</sup> which dominated evolutionary theory over a century, was complemented with a principle of ‘convergence’. And the principle of competition was matched by one of cooperation. Symbiosis occurs on every biological level: as horizontal gene transfer in bacteria and plants, as endosymbiosis in early cellular evolution, and as organismic symbiosis in its manifold manifestations in the evolving world of multicellular organisms. Last but not least, it finds its expression in sexual reproduction, which Margulis appropriately designated as ‘cyclical symbiosis’.<sup>15</sup> The consequent and persistent formulation of this mode of evolution put Margulis, for the twentieth century, on a par with Charles Darwin for the nineteenth. And in fact, her *modus operandi* was very similar to Darwin’s: a natural history approach. But the similarities go further: Margulis could also tell stories like Darwin. ‘Even scientists’, she acknowledged, ‘need to narrate, to integrate their observations into origin stories’<sup>16</sup>—be it the origins of their epistemic objects or the origins of their own research topics. Just as Darwin’s ‘struggle for survival’ advanced to a social slogan in the nineteenth century and has remained so to this day, symbiosis should have advanced long since to become a catchword of the same order. Unfortunately, we are still waiting for this to happen.

### THE NATURAL CONTRACT

This is the point at which we can home in again on Michel Serres. He, too, relies on scientific observations. Rather than speaking as a scientist, however, he speaks and tells stories as a very special kind of philosopher: one who sees it as philosophy’s task ‘to anticipate the future’, as he puts it.<sup>17</sup> No owl of Minerva here, that has haunted philosophical knowledge since the days of Hegel with its ‘grey in grey’.<sup>18</sup> Serres is instead a thinker of the Anthropocene *avant la lettre*. In this respect, it is worth looking at his arguments in more detail.

Michel Serres found drastic images for the planetary situation. His book begins with the portrayal of a painting by the Spanish painter Francisco de Goya, reproduced here.

Two youngsters are fighting with batons in a dune-like landscape. Each of them tries to hit the other with his rod. Forgetting everything around them, they do not realise that they are sinking deeper into the sand with each blow. The ground on which they are standing is going to engulf them. They have lost sight, that is, of the material support that sustains

<sup>12</sup> Michel Serres, *The Parasite* (Lawrence R Schehr tr, Johns Hopkins University Press 1982).

<sup>13</sup> Margulis, *Symbiotic Planet* (n 11) 52.

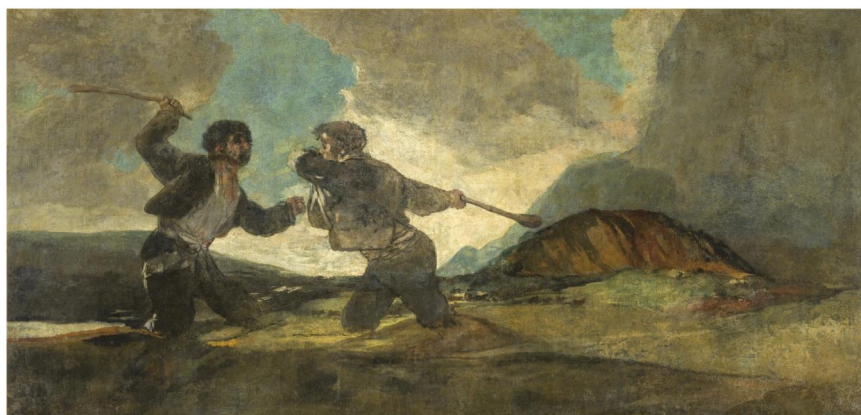
<sup>14</sup> Hans-Jörg Rheinberger, ‘Darwin, „Diversität“ und Evolution. Ein historisches Aperçu’ in Volker Gerhardt, Klaus Lucas and Günter Stock (eds) *Evolution: Theorie, Formen und Konsequenzen eines Paradigmas in Natur, Technik und Kultur* (Akademie Verlag 2011) 89–94.

<sup>15</sup> Margulis, *Symbiotic Planet* (n 11) 103.

<sup>16</sup> *ibid* 70.

<sup>17</sup> Serres, *Retour* (n 7) 22.

<sup>18</sup> Georg Wilhelm Friedrich Hegel, *Elements of the Philosophy of Right* (first published 1821, Hugh B Nisbet tr, Cambridge University Press 1991) 23.



**Figure 1:** Francisco de Goya y Lucientes, *Duelo a garrotazos* (1820). Source: Museo Nacional del Prado.

them both, the third party that mediates their relationship, their social interaction. This is how Serres transposes the fight:

Take away the world around the battles, keep only conflicts or debates, thick with humanity and purified of things, and you obtain stage theater, most of our narratives and philosophies, history, and all of social science: the interesting spectacle they call cultural. Does anyone ever say *where* the master and slave fight it out?  
Our culture abhors the world.

He adds a question:

aren't we forgetting the world of things themselves, the sand, the water, the mud, the reeds of the marsh?

and he concludes:

We have lost the world. We've transformed things into fetishes or commodities, the stakes of our stratagems; and our a-cosmic philosophies, for almost half a century now, have been holding forth only on language or politics, writing or logic.<sup>19</sup>

As far as the discourses of contemporary philosophy are concerned, Serres' somber diagnosis is that '[n]ature is reduced to human nature, which is reduced to either history or reason. The world has disappeared.'<sup>20</sup> Serres' merciless bashing of philosophy, however, comes to a halt in the face of knowledge produced by the sciences of nature. He does of course not claim at all that the natural sciences were not socially constituted as well, and that they would not be tainted by history and contemporary theorising—quite the contrary. But in one decisive aspect, he considers, they differ: They simply cannot ignore the recalcitrance of their objects as easily as the humanities obviously can.

<sup>19</sup> Serres, *Natural Contract* (n 1) 2–3, 29 (emphasis added).

<sup>20</sup> *ibid* 35.

This difference rests, Serres argues, on the necessity, in scientific knowledge acquisition, of a continual, realtime passage from cause to thing and from thing to cause, a reciprocal transition that makes a fact become a law, *de facto* become *de jure*, and a law become challenged by a fact. Serres coins a *new* word for this relation—‘epistemodicy’, meaning ‘all relations of science and law, reason and judgement’.<sup>21</sup> And he reclaims another, *old* word from jurisprudence for it, that of ‘natural law’ which, as he says, ‘conceals a profound contradiction’.<sup>22</sup> The reciprocal transition from cause to thing and from fact to law, that inextricable interconnection of concept and phenomenon established and practiced by the sciences of nature, explains the double-bind specific for scientific knowledge: it is, on the one hand, arbitrary convention, as is all speculative theory, and, on the other hand, faithful and exact objectivity without which its technical applications would be unthinkable. Serres repeatedly returns to this ‘double situation’,<sup>23</sup> as he calls it, and circles around it again and again. It is, so it seems, a struggle that has no analytical solution. It carries with it an irresolvable tension, a tension that must be lived through again and again.

In his *Méditations pascaliennes*, Serres’ French contemporary Pierre Bourdieu characterised this dilemma as the inescapable ‘dual face’ of scientific reason. He found the following words for it that are worth quoting at length:

While it forbids one to move fictitiously beyond the uncrossable limits of history, a realist vision of history leads one to examine how, and in what historical conditions, history can be made to yield some truths irreducible to history. We have to acknowledge that reason did not fall from heaven as a mysterious and forever inexplicable gift, and that it is therefore historical through and through; but we are not forced to conclude, as is often supposed, that it is reducible to history. It is in history, and in history alone, that we must seek the principle of the relative independence of reason from the history of which it is the product; or more precisely, in the strictly historical, but entirely specific logic through which the exceptional universes in which the singular history of reason is fulfilled were established.<sup>24</sup>

Now, the sciences play—aside from the peculiar constitution of their rationality—at the level of practice, of physical intervention, an equally inextricable double role in that ‘world drama’ of our times which is the subject of Serres’ book. On the one hand, it is to the technical reifications of the sciences that we owe those ‘world-objects’, that is, those ‘artifacts that have at least one global-scale dimension (time, space, speed, or energy)’,<sup>25</sup> such as: ‘A satellite regarding speed, an atomic bomb for its energy, the internet with respect to space, atomic waste for time ... these are four examples of world-objects.’<sup>26</sup> These are the objects that stand in for the massive and potentially devastating global effects of our actions on the planet and its atmosphere, *the* big issue of the Anthropocene. For Serres, the atomic bombs on Hiroshima and Nagasaki were the turning point at which the new era definitely began. By these bombs, he states, ‘my generation learned, as the first generation in history, that mankind as a whole faced the risk of extinction’.<sup>27</sup>

<sup>21</sup> *ibid* 22.

<sup>22</sup> *ibid* 23.

<sup>23</sup> *ibid* 22.

<sup>24</sup> Pierre Bourdieu, *Pascalian Meditations* (first published 1997, Richard Nice tr, Polity Press 2000) 109.

<sup>25</sup> Serres, *Natural Contract* (n 1) 15.

<sup>26</sup> *ibid* 12.

<sup>27</sup> Serres, *Biogée* (n 1) 10.

On the other hand, of the three social powers that today, according to Serres, are the big players and dominate our affairs as well as our view on the world—administration, journalism, and science—the sciences are the only power oriented toward the future. ‘Continuity belongs to administrators, the day-by-day to the media, and to science belong the only plans for the future we have left.’<sup>28</sup> It remains thus as the main task for and is incumbent on the sciences to care about ‘the greatest object of scientific knowledge and practice, the Planet Earth, this new nature’.<sup>29</sup> And although today, according to Serres, all three of the powerful subcultures mentioned, the sciences comprised, are driven by short-term concerns, it is the sciences that he sees as best qualified to induce that ‘harrowing revision of today’s culture’ that will be necessary to keep the planet habitable.<sup>30</sup> ‘Today’, Serres sums up, ‘our collectivity can equally well die of the productions of reason or safeguard itself through them.’<sup>31</sup>

The cover of the original edition with François Bourin of *Le Contrat naturel* nicely captures this double-sidedness. It shows an oversized book whose pages are kept open by a dwarfed planet. On the one hand, the sciences and their technological output threaten to devour the earth; on the other hand, it is the planet that keeps the pages of the book of science open.

## ENTER THE HISTORY OF SCIENCE

For Serres, as has already become evident, the sciences play a privileged role in the actual situation in which the planet finds itself. This circumstance sheds light, too, on the fact that Michel Serres, in parallel to the preparatory work for his book on *The Natural Contract*, assembled a group of younger historians of science around himself, with whose help he aimed to establish an unprecedented project in the history of the sciences.<sup>32</sup> Its result was published in 1989, one year before *Le Contrat naturel*, under the title *Éléments d’histoire des sciences*.<sup>33</sup> It united the contributions of a dozen authors with either a philosophical, historical, or mathematical background—among them Bernadette Bensaude-Vincent, Bruno Latour, and Isabelle Stengers. Spanning a time period from antiquity to the present, they all tried to understand the historically concrete conditions under which the *material objects* of the different sciences took shape and became themselves something like actors in the development of the respective fields of knowledge. The book stands as a paradigm for the core concern of what came to be called the ‘material turn’ in the history of science.

In *The Natural Contract*, Serres consistently talks about the history of the sciences. He narrates this history in broad strokes with a focus on the history of objects constituted by iterative judicial shifts and relocations. For Serres, drawing demarcation lines appears as the motor of scientific development from its beginnings in the antique world. He describes the state of mind of the Greek polis with flowery phrases: ‘What is nature? The city or culture’s hell. The place where the banished king was cast out, the city’s outskirts, suburbs.’<sup>34</sup> For a long time, it was the cup of hemlock that stood as punishment for the exclusive occupation with nature, instead of the affairs of the city. It is only gradually, Serres continues, that ‘the

<sup>28</sup> Serres, *Natural Contract* (n 1) 30.

<sup>29</sup> *ibid* 30.

<sup>30</sup> *ibid* 31.

<sup>31</sup> *ibid* 93.

<sup>32</sup> It is remarkable that the French language, in contrast to the German or English language, generally uses the plural ‘sciences’ when speaking about their history or philosophy, indicating and acknowledging their plurality.

<sup>33</sup> Michel Serres (ed), *A History of Scientific Thought: Elements of a History of Science* (first published 1989, Blackwell 1995).

<sup>34</sup> Serres, *Natural Contract* (n 1) 73.

sciences split off from politics, their terrain is distinguished from collective space, their contract differs from the social contract, their language is neither spoken nor written like public discourse, and the history of their truths is full of bifurcations'.<sup>35</sup> With hindsight, we must look at this separation as a major historical event. 'We don't know how lucky we are that our minds are relieved of this social cord'—Serres refers to the Greek polis here—'as a result, they can turn to real sciences!'<sup>36</sup>

Today, however, two and a half millennia after this consequential historical separation, the sciences themselves have turned into a social force. They have turned into an all-encompassing social fact; they have ended up tending to impose their truths on jurisprudence and on politics. But, Serres contends, the sciences must beware of betraying their painstakingly achieved lay status as a result of this development: Their core continues to consist, paradoxical as this may sound, in the right to have gotten it wrong. Here again, what is necessary is a new contract. No party—neither politics nor science—can exist any longer without each other, but they also cannot and must not be reduced to each other, or even fused together.

Thus, what has to be done is to conclude a *new contract* between reason, which deals relevantly with the things of the world and their relations, and judgment, which decides on living beings and their relations. It is better to make peace between the two types of apprehension that are in conflict today, because their fates henceforth cross each other and are blended, and because our own fate depends on this broader alliance.<sup>37</sup>

If the sciences derive from the right to err, law derives from death. Both have thus their origin in an essential negativity. Today, however, we no longer live—as since time immemorial—in the face of individual death, but in the face of a possible *collective* death. Confronted with this new death, Serres argues: 'We need both reasons, faithful knowledge and prudent judgment.'<sup>38</sup> Knowledge and judgment do not exclude each other, but neither are they reducible to one another.

## BRUNO LATOUR AND GAIA

One of the younger people Michel Serres had gathered around himself in his project on the history of the sciences was Bruno Latour. Latour's conversations with Serres of that time, reproduced in *Eclaircissements*,<sup>39</sup> are still as worth reading and as relevant today as they were back then. Serres' topics of that time formed the background of Latour's later actor network theory (ANT) that would become so prominent. The latter's book on the *Pasteurization of France*,<sup>40</sup> devised as a historical foundation to ANT, took shape in the years of his collaboration with Serres. As is well known, Latour has turned to Gaia and the Anthropocene in recent years, carrying on one of Serres' preoccupations from the late 1980s, and adding his own voice to the acknowledgement of its urgency. In his *Facing Gaia*,<sup>41</sup> Latour makes use of all the conceptual and rhetorical tools at his disposal to convey this sense of urgency. In good company with Margulis, Latour is outspoken about denying Gaia something like a 'supreme Final Cause'. But Margulis would certainly not agree with

<sup>35</sup> *ibid.* 78.

<sup>36</sup> *ibid.* 69.

<sup>37</sup> *ibid.* 92.

<sup>38</sup> *ibid.* 93.

<sup>39</sup> Michel Serres and Bruno Latour, *Conversations on Science, Culture, and Time* (first published 1992, Roxanne Lapidus tr, University of Michigan Press 1995).

<sup>40</sup> Bruno Latour, *The Pasteurization of France* (Alan Sheridan and John Law tr, Harvard University Press 1993).

<sup>41</sup> Bruno Latour, *Facing Gaia. Eight Lectures on the New Climatic Regime* (Cathy Porter tr, Polity Press 2017).

Latour's characterisation of the surface of the earth and its atmosphere as simply a 'fine muddle'.<sup>42</sup> Margulis' whole argument revolved around the fact that it is just *not* a muddle. It *can*, however, as a metastable system, collapse into a bog. It is the preservation of this metastable state that is the order of the day. With his lectures on *Facing Gaia*, Latour has sharpened and focused his critique on the dichotomy of nature and culture, this conceptual invention of the modern age that the makers of our epoch themselves, in all their doings, have never respected. This was Latour's mantra since *We Have Never Been Modern*,<sup>43</sup> that small but influential little pamphlet published in the wake of Serres' *Natural Contract*. Latour's more recent, radicalised conclusion is: 'Besides, the notion of culture itself—together with the notion of nature—has vanished. We are post-natural—that is true; but we are also post-cultural.'<sup>44</sup>

Be that as it may, it is clear that a new conceptual framework is needed. But instead of replacing the old dichotomy with another one, what is needed is to complicate the matter. In 2010, in his *Biogée*—we can read this book as an autobiography—Serres writes:

My hope lies on the actual development of *knowledge*. Simple and facile, our old sciences were based on analysis that breaks up and dissects, a decomposition that separates the subjects from their objects. ... Complicated, global, and networked, the—new—sciences of life and earth presuppose communications, interferences, translations, distributions, and transitions. ... Let us recognize, with Empedocles, the urgency of a union between wisdom and knowledge, and that under penalty of collective eradication.<sup>45</sup>

In short, and as a question: 'Could science, overwhelmingly analytic, consider an object in its totality for the first time?'<sup>46</sup> And he answers: 'We are going to change paradigm.'<sup>47</sup>

### THE PEASANT, THE MARINER, AND THE WANDERER

In a late conversation with Michel Serres, Stéphanie Posthumus has observed that the figures that give *The Natural Contract* and, in particular, *Biogée*—Serres' neologism for the ensemble of the earth and its living beings—its narrative imprint are the *peasant*, the *mariner*, and the *wanderer*. These personae are to be understood, not in and by their traditional ways of living, but in and by their *attitudes* toward the worlds in which they live, and that have tended to be forgotten over the course of time:

The peasant lives with all the other living beings around him under one roof and believes in a soul of things and of the world. The mariner obeys an ethics of governance in his handling of wind and water that is shaped by precaution and by prudence. The wanderer finally is the model of an aleatoric and creative choice of moving forward. She does not follow one method in the sense of *the one* right path, irrespective of the places that she traverses. She respects the particular conditions of the real world she encounters.<sup>48</sup>

<sup>42</sup> *ibid.* 100.

<sup>43</sup> Bruno Latour, *We Have Never Been Modern* (first published 1991, Catherine Porter tr, Harvard University Press 1993).

<sup>44</sup> Bruno Latour, 'Warten auf Gaia: Komposition der gemeinsamen Welt durch Kunst und Politik' in Michael Hagner (ed), *Wissenschaft und Demokratie* (Suhrkamp 2012) 185 (author's translation).

<sup>45</sup> Serres, *Biogée* (n 1) 81–82 (author's translation) (emphasis added).

<sup>46</sup> Serres, *Natural Contract* (n 1) 6.

<sup>47</sup> Serres, *Biogée* (n 1) 43 (author's translation).

<sup>48</sup> Stéphanie Posthumus, 'Un contrat mondial longue durée: Entretien avec Stéphanie Posthumus—Propos recueillis par Emmanuel Levine' in *Philosophie magazine* (Hors série, Michel Serres, Automne–Hiver 2018) 53 (emphasis added).



It is these attitudes toward the world that Michel Serres, under the particular conditions of the present, calls for re-appropriating, through his writings from the 1990s onward. These figures are by no means meant as a step back to the good old times. Rather, Serres invites us to reconsider the relations that humankind, including all scientific and technical sophistication it has today at its command, will have to re-establish with the planet, if future generations are to retain the option to inhabit a livable environment. In order to grant it, we are in need of sciences that are able to consider and manage complex relations, including the contingencies and singularities that arise from them. Serres was convinced that the sciences of the earth and of life have launched on the path to perforate the nature-culture divide, pleading for what Gaston Bachelard already announced with his sketch of a new, non-Cartesian scientific spirit,<sup>49</sup> and what Isabelle Stengers and Ilya Prigogine called, a decade before Serres' *Contract*, *La Nouvelle alliance*.<sup>50</sup>

The simple message to derive from all this is that our planetary responsibility as natural and as social scientists, as historians and as philosophers, consists in promoting this transition on all possible levels and with all imaginable means. Making peace with the earth will depend on our ability to manage the transition to a science of complexity. The most important thing of all things is that we have to learn to become better scientists.

<sup>49</sup> Gaston Bachelard, *The New Scientific Spirit* (first published 1934, Arthur Goldhammer tr, Beacon Press 1984).

<sup>50</sup> Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (first published 1979, Bantam Books 1984).

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Review Essay