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toward a symbiotic way of thought

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Lichens

Toward a Minimal Resistance

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polity

Part 4
TOWARD A SYMBIOTIC WAY OF THOUGHT

"Rights of symbiosis are defined by reciprocity."
Michel Serres, *The Natural Contract,* 1992

Lichen's incredible resistance is due to a very particular biological phenomenon: symbiosis. During our first encounter, when, with the energy and innocence a new research project prompts, I entered Philippe Clerc's office where the species for his latest study lay drying, he said to me, "Do you know that we have just discovered, in 2016, a third organism within lichen?" How is that possible, a *third organism* within lichen? I picked up a sample of *Xanthoria parietina* and examined its dried yellow plate, with its apothecia in the form of tiny suction cups. Where could a whole little world be hidden? You need good eyes: lichen's dual nature was only discovered in the 1860s.

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One of lichen's most spectacular characteristics is undoubtedly its symbiotic nature. It actually unites many partners into a single individual: a "photobiont" (the algae, ensuring photosynthesis and, for that reason, often located in the superior layer of the thallus, close to the light, and providing nitrogenous and carbon-emitting materials, sugars and proteins, to the fungus – which can also be a cyanobacteria) and a "mycobiont" (the fungus, which provides

structure and thus protection for the algae, as well as water, carbon dioxide, and mineral salts necessary for photosynthesis). Sometimes a second "mycobiont" is added (a basidiomycete "yeast") that takes part in the synthesis of the famous lichenic substances (it was discovered because two species of the *Bryoria* genus were different colors but their symbiotic partners were identical), and other microscopic partners.

"Lichenization" is the invention of a porous lifestyle, open to cooperation. Lichen is considered to be the result of a nutritional "strategy" of the fungus. In fact, the fungus is a *heterotrophic* organism: incapable (like human beings) of making the organic material it needs to nourish itself. Thus it needs other living beings: it can make use of the decomposition of soil ("saprophytism"), parasitize other species, or combine with them, as in the case of mychorrhizea and lichens (as for algae, they are *autotrophic*: they produce their own organic material from inorganic material and minerals through photosynthesis). In this sense, lichen is a fungus that, in order not to depend on decomposition, cultivates algae, as though in a greenhouse, allowing it to live at greater heights. And it is because of this heterotrophy, which distinguishes it from plants, that the immobile fungus is essentially symbiotic: obliged to cohabit.

The photosynthetic activity of chlorophyllic plants is coveted by other heterotrophic organisms. Other "photo-symbiotic" groupings were later discovered, notably in aquatic environments: the Roscoff worm (*Symsagittifera roscoffensis*) and the coral polyp both cohabit with single-celled algae for their respiration and nutrition (in the first case, the *Tetraselmis convolutae* alga, ingested without being digested by the Roscoff worm and surviving under its epidermis; in the second case, the zooxanthella, of the *Symbiodinium* genus). In these cases, they unite animal and vegetable kingdoms.

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In *lichen* there is *link*. For many years now, certain biologists, philosophers, and artists have seized on this organism to question

the notion of biological individuality (*indiv*: in Latin, that which cannot be divided, like Leibniz's monad, Lucretius' atom). The idea of the oneness and sovereignty of the individual, which sprang from Kantian and Romantic ideas on the subject, was gradually undermined on the philosophical level by Nietzsche, on the psychological level by Freud, and on the linguistic level over the course of the twentieth century.

Once again, lichen is in full dialogue with modernity. From a biological perspective, symbiosis is a notion that was discovered and defined at the end of the nineteenth century, beginning precisely with lichen.[1] Since then, symbiosis has been observed among a great number of living beings, including humans, and on different scales (from cellular to ecosystems). Almost all beings live symbiotically, that is, in an interdependent relationship (mutual or parasitic) with other beings in their environments. This phenomenon was only recently considered in the history of the sciences. As biologist Marc-André Selosse notes, "long taught as a series of biological anecdotes, [...] symbiosis is not anecdotal. The scientific community was slow to become aware of it and it wasn't until the 1970s that conferences were held on this subject."[2]

Every *bios* is *symbios*. Every organism appears as an ecosystem in interaction with a "symbiotic retinue" (with which it cooperates or struggles), laying out the principle of a dynamic ontology.

> No organism lives alone, and each possesses a symbiotic retinue without which neither its physiology nor its ecological success can be understood. This retinue is practically always present, since without it, the organism dies or sees its competition reduced.[3]

The Politics of Lichen: At the Origins of Symbiosis

From a political perspective, lichen could be rehabilitated through discourse idealizing the concept of symbiosis by reducing it to a

"mutualist" definition: not only do the partners, fungi and algae, live together, but they mutually benefit one another. That way of life serves here as a projection of a model of social harmony, essentially Marxist, perhaps aimed at establishing a "biotariat" (Stephen Collis).[4] Old images, coming from ideas on universal harmony, could thus be readopted, like this passage from the poet John Donne (1572–1631) that shows up in blogs and features Man in harmony with the All: "No man is an island, entire of itself; every man/ is a piece of the continent, a part of the main." Insularity versus globalism.

That is the case, for example, with Scottish poet and academic Drew Milne (born in 1964). His *Lichens for Marxists* (2017), published on line, brings together "poem-lichens": poem-emblems consisting of photographs of various lichens on which are superimposed slogans or lines of poetry that advocate ecological resistance to capitalism. These aphorisms, or rather these placards for poetic demonstrations, are in conversation with the history of modernity and the literary avant-garde, who have deliberately played with the codes of advertising materials and political tracts since the late nineteenth century. Let us think, for example, of José Asunción Silva, Blaise Cendrars, Guillaume Apollinaire ("You read the prospectuses the catalogues the billboards that sing aloud/That's the poetry this morning and for prose there are the newspapers"), Dada, the visual and sound poets. And just like lichen (often, in any case), the placard appears on a vertical support, a wall. The lack of punctuation clearly shows this rejection of closure, and the "we" becomes the new pronoun for the symbiotic subject:

> we the symbiotic alliance of lichen/ hold the evident truth to the self/ namely that all lives are not made/ the same and the carbon liberation/ front will be the death of all but/ the persistent solidarity of algae.[5]

But let us return to the origins of the word "symbiosis" and the inner "solidarity" of lichen.

The word appeared relatively recently. In 1825, German botanist Karl Friedrich Wilhelm Wallroth (1792–1857) observed entities present in lichens that he called "gonidia," and that were actually algae.[6] The dual nature of lichen was discovered, and thought of as such, for the first time in 1866 by another German botanist Heinrich Anton de Bary (1831–1888), and in 1867, by Swiss botanist Simon Schwendener (1829–1919). Microscopic observation of the organism's growth revealed that fungi filaments and algae nuclei developed at the same time. From then on, lichen no longer appeared as an autonomous kingdom, but as the union of two organisms: a complex that contained algae surrounded by fungi filaments. That is what Schwendener called the "algo-lichen hypothesis." At the same time, in 1867, Russian botanists Andreï Sergueïevitch Famintsyne (1835–1918) and Josep Wasilijevitsch Baranetzky (1843–1905) made similar observations by succeeding in isolating gonidia (algae reproductive cells in lichen) from *Xanthoria parietina* and *Pseudevernia furfuracea* and making them grow outside of the lichens. Until the 1890s, German and Russian scientists especially represented the leading edge of research on symbiosis.

In 1868, Schwendener wrote: "I believe that lichens are not autonomous plants but fungi (ascomycetes) for which algae, about whose independence I have no doubt, serve as foster plants."[7] This union was immediately viewed by Schwendener as an asymmetrical relationship: the fungus was a parasite of the algae that it held in the claws of its hyphae. A lichen is "a community composed of a master fungus and a colony of algae slaves that the fungi holds in perpetual captivity so that they provide it with food," he also wrote. In this period, scientific theories of associations were conceived beginning from animals and essentially took the form of parasitism, until new interactions could be imagined (commensalism, mutual aid).

This way of thinking about living beings was revolutionary. Lichens would no longer be "elementary" or "rudimentary" plants,

but complex and particularly evolved structures. Plural individuals could exist. Thus intense controversy developed within the scientific community, between those adhering to the autonomy of lichens and the "Schwendenerians" who promoted the "algo-lichen hypothesis." Insults flew back and forth and publications became manifestos and pamphlets. There was also a generational divide. That was the case with Famintsyne, and again with Finnish botanist William Nylander who, until his death in 1899, refused to believe in the dual nature of lichens and decided to stop frequenting the French National Museum of Natural History in Paris where he did his work, arguing that the researchers there had taken up the "Schwendenerian" cause!

Thus 1867 was an important year. It was also the year of Baudelaire's death and the publication of the first book of *Das Kapital* by Karl Marx, who was trying to "decapitate" a vertical social body.

In fact, for scientists convinced that lichen was no longer an autonomous realm, the only subject for debate now was the nature of the relationship between the fungus and algae. Parasitism, said

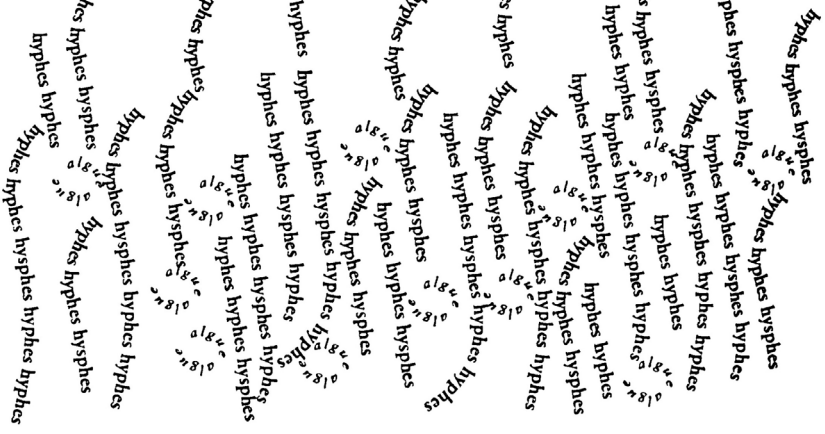

Figure 12 © Nathalie Ravier, "Glossary of terms currently used in lichenology," prints on tracing paper, p. 19.

Schwendener. It would be ten years before this cohabitation could be conceived differently. The work of Belgian zoologist Pierre-Joseph Van Beneden (1809–1894) headed in that direction. In 1875, he spoke of "mutualism" in his treatise, *Les Commensaux et les parasites dans le règne animal.* Albert Bernhard Frank (1839–1900), curator for the University of Leipzig herbarium, coined the word "symbiotismus" in 1877:

> The relationship in question is something much more than simple parasitism in the usual sense, because while we imagine that originally or generally lichens lack gonidea, in fact, the parasites and the host are united from the start to constitute a new unified organism. [...] From the union of the two organisms ... the formation of a specific new form results. [...] In any case, this is based solely on "living together" and that it why we can recommend using the term *symbiotismus* to refer to these cases. The phenomenon is not to be considered completely parallel to what happens with parasites of animals, like certain parasitic fungi and in particular those that make galls. [...] *A relationship in which the parasite also cares about the nutrition of its host takes on a different significance from parasitism.*[8]

Parasitism was an outdated notion because it did not allow for the formation of an organism beginning from an initial union of two different organisms, nor for the idea that the host organism (the algae) could benefit from this arrangement. The following year, Alsacian German botanist Anton de Bary defined "symbiosis" as "the shared life of organisms with different names."[9] "Mutualism," "symbiotism," "symbiosis": it is the last word that stuck and that would have a long future. Frank and de Bary defined the concept of "symbiosis" as the "living together," "in common," of different species (the etymological meaning in Greek for *symbiosis*), lasting over the course of their lives (the political), within a shared external or internal habitat (the ecological). Thinking of this "living together" allowed for moving beyond Schwendener's theory,

because it did not imply a mode for that shared life. For de Bary, what was important was the creation of a unity of life common to two organisms.

In the 1880s, plant roots got their turn to be analyzed from the symbiotic perspective. The fungi discovered on roots in the 1850s, first conceived as parasites, became symbiotic and were named "mychorrhizea" by Albert Bernhard Frank in 1885.

Symbiosis marked another major upheaval. Henceforth, living beings were considered much more in relationship to their environments. 1866 was also a landmark year: in addition to de Bary's discovery of lichen's dual nature, Nylander demonstrated the role of lichens as bioindicators for urban pollution, and German biologist Ernst Haeckel (1834–1919) coined the word "ecology" ("oecologia") in the scientific sense of the habitat of living beings.[10] He defined it as the science "of the relationships of organisms with the surrounding world, that is, in a larger sense, the science of conditions of existence" (it is said that Thoreau might have coined the word about ten years earlier). If symbiosis was discovered at this precise moment, it's also because scientists were beginning to think about "ecology" in biology; lichen facilitated the development of this ecological thinking.

Contrary to the English use of the term, "symbiosis" in French has since integrated an important factor: the phenomena of lasting cohabitations within living beings (its etymological meaning) must involve reciprocal benefits. We can say, in English, that symbiosis is a kind of politics; in French, that politics is mutualist.

In order to be able to include the phenomenon of parasitism in this reflection on symbiosis, I have chosen to adopt the expanded, English definition here. Hence, there can be *symbiosis without mutualism* (of the parasitic or companionate type, like pigeons or cockroaches profiting from human food scraps) and *mutualism without symbiosis* (without lasting cohabitation, like the pollination of flowers by insects or the organisms that ensure the dispersion of seeds).

1866, 2016: one hundred and fifty years later, a third partner was discovered within this symbiotic ecosystem: a basidiomycete fungus (a yeast). The lichenic couple actually hides a ménage à trois.

Since then, new microscopic components have been located in the thallus (cyanobacteria, micro-algae, micro-fungi, bacteria, amoebas, viruses) that all also contribute "actively to maintain the shared living that characterizes lichen."[11] In 2020, David Leslie Hawksworth and Martin Grube proposed this new, expanded definition of lichen: "an autonomous ecosystem formed by the interaction of an 'inclusive' fungus, an extracellular organization of one or many photosynthesizing partners, and an indeterminate number of other microscopic organisms."[12]

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I decided to research ancient texts. After long weeks of investigation, in the library and on line, I found that in ancient Greek, contrary to the generally accepted idea, the word *sym-biosis* already existed, and well before the historian Polybius (205–123 BCE), very often mentioned as the inventor of the word.[13] It is present in Antisthenes, Aristotle, Hecataeus, and so on. Used infrequently, it already designated a shared life, literally, the act of living together, involving two spouses, two companions, or two friends. In short, it described an experience of harmonious cohabitation (the "symbiosis" of two brothers who share the same opinion, having grown up together, in Antisthenes; that of a man and woman, made for living together, in Aristotle; that of astrologers and courtiers with regard to their king, in Hecataeus and Polybius; that of father and son, again in Polybius). Moreover, the word *symbios* existed as well, in the sense of male or female "companion," "one who lives with," – a "partner," to return to Frank's word.[14]

But what is most interesting and most novel, and which once again runs counter to received ideas (which make Frank and de Bary the inventors of the word in biology, disregarding the fact that phenomena of mutual partnerships had long been observed),

is that we also find in ancient Greek some instances (two) which, beginning from the primary meaning of social cohabitation, relate to the biological realm through metaphor.[15] In his *Treatise on the Intelligence of Animals,* Plutarch (46–125) mentions many cases of animals living in "society."[16] One example he traces back to Chrysippus: *pinnotheres*, a small crab that lives in shellfish.

> As for the rest that are seen to swim in shoals and to observe a mutual society, their number is not to be expressed. And therefore let us proceed to those that observe a kind of *private and particular society one with another.*[17] Among which is the pinoteras of Chrysippus, upon which he has expended so much ink, that he gives it the precedency in all his books, both physical and ethical.[18] For Chrysippus never knew the spongotera, for he would not have passed it over out of negligence. The pinoteras is so called, from watching the fish called pina or the nacre, and in shape resembles a crab; and cohabiting with the nacre, he sits like a porter at his shellside, which he lets continually stand wide open until he spies some small fishes gotten within it, such as they are wont to take for their food. Then entering the shell, he nips the flesh of the nacre, to give him notice to shut his shell; which being done, they feed together within the fortification upon the common prey.[19]

This account presents two animals described as two friends in the process of playing a trick on small fishes. The rewards are mutual, according to Plutarch: the crab gives the warning, the pina does the trapping, the two of them eat.

Such phenomena were thus observed even in antiquity, and it is striking that the word used, even if it was not yet conceptualized, is the same, one thousand, seven hundred and fifty years earlier. This *princeps* example was then passed down through the ages and became a classic in zoological and philosophical works, as well as for Philo of Alexandria (*De Animalibus* [The Soul of Animals]), Montaigne (*Essays*)[20] and Ambroise Paré, who wrote in

1582, "the pina and the pinoteras render mutual services to each other, they cannot live without one another."[21] Other scientists are inclined toward the unique benefit of the crab, like Van Beneden, who takes up the example again in 1875 to present the concept of commensalism (a partnership of organisms of different species, profitable for one of them, without endangering the other). Similarly, philosopher and naturalist Theophrastus (371–288 BCE), one of the first to name "lichens," in mentioning the various reproduction methods of the olive tree (which may seem very dated to us) expressed the relationship that the tree could have with ivy in this way:

> However all plants start in one or other of these ways, and most of them in more than one. Thus the olive is grown in all the ways mentioned, except from a twig. [...] Not that what some say that cases have been known in which, when a stake of olive-wood was planted to support ivy, it *actually lived along with it* and became a tree; but such an instance is a rare exception.[22]

The Greek word "symbiosis" was then reused, for the first time in a political sense, by German philosopher and Protestant theologian Johannes Althusius (1557–1638). In 1603, he imagined political life as structured by associations of small communities of citizens called "symbiotes." This line of thinking fell within the context of an emerging form of democracy in seventeenth-century Germany, which would serve as the source of the model for European democracy. In this sense, "symbiosis" (sometimes described as "sympathy") is only another name for the body politic ("shared life" etymologically speaking, but on the scale of society as a whole). It allows for conceiving of a form of social harmony through the reciprocity of benefits that it may involve (La Boétie revealed to us the intentionally dependent relationship concealed behind the monarchy [...]). These links between organic bodies and political bodies were not new: Plato had already proposed them, but in a vertical and ontological dimension. That is because

any concept of life, any biology, rests upon a philosophical, and thus political base.

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For that matter, wasn't the thinking on lichenic symbiosis made possible – putting technical innovations aside (the microscope)[23] – by the fertile ideological ground of the nineteenth century?

That is because, especially in that period, the social (political) world and organic (biological) world were conceived as a single continuum, whether according to Platonic, Romantic, Hegelian, or even Darwinian views (human and other living beings are considered on the same plane). As evidence, witness the great number of words used indiscriminately for both these worlds: "societies" was used for animals and plants; "commensalism" was invented in 1874 (just before "symbiosis") to describe biological interactions; conversely, social "parasitism" was criticized in the eighteenth century, and so on. The world was seen as one, *bios*

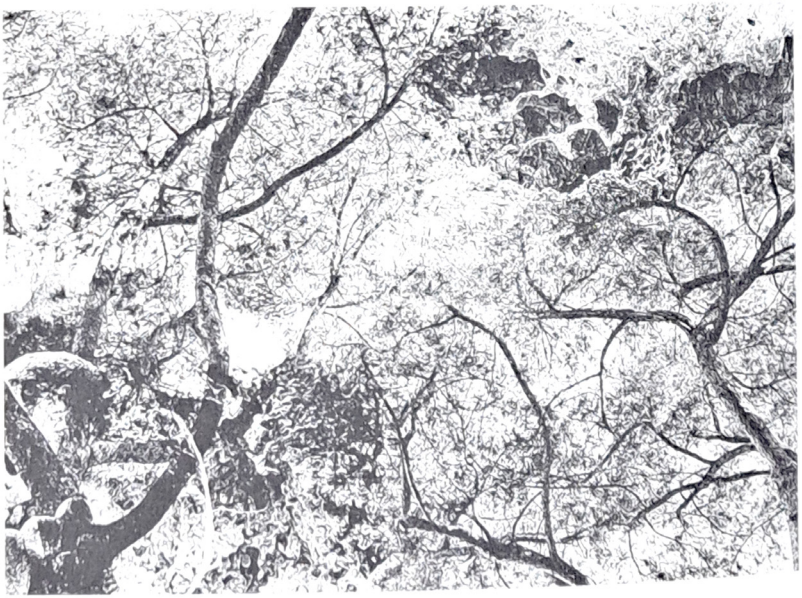

Figure 13 © Pascale Gadon-González, *Biomorphose* (4991), 2019, gum bichromate print, with *Xanthoria* lichen, Rome, Italy, 30 x 40 cm.

like *polis* both regulated by the same laws (let us think of social Darwinism [...]).

The writings of Charles Fourier (1772–1837) constitute a particularly spectacular example. The founder of social utopian communities that he called "phalanxes" conceived the world as a great All (*Théorie de l'unité universelle* [*Theory of Universal Unity*], 1822–1823) and sought to establish ties between "natural and social things." A great lover of botany, flowers in particular (his mother was named Marie Muguet!), he demonstrated the importance of the plant world for thinking about humans, notably the human soul.[24] "A fruit, a leaf, a root, are a mirror to our souls, the play of our passions." Nature is a mystery that poets endeavor to decipher (this is the vision of Baudelaire and Caillois):

> The ancients had thus glimpsed the secret of nature, general analogy. They began with an accurate principle, but they did not know how to apply it. Their allegories were fantastic; they lacked a theory of interpretation, the art of methodically explaining the meaning of each animal, vegetable, and mineral hieroglyph.[25]

It is not surprising then to see Van Beneden presenting this analogy at the beginning of the seminal work on mutualism in biology:

> Upon close examination, one finds more than one analogy between the animal world and human society and, without looking very far, one could say that there hardly exists a social position that does not, I dare say, have its counterpart among the animals. Most of them live peaceably on the fruit of their labor and practice an occupation by which they live. But alongside these honest workers, one sees those wretches who could not get by without the aid of their neighbors.[26]

The thinking on symbiosis took place in dialogue with the philosophical and political ferment of the nineteenth century

– specifically the 1850s and 1860s – that allowed for its growth. The term "mutualism" appeared in 1828 to denote a mutual aid society of weavers in Lyon, in the context of the economic crisis that affected the Lyon silk workers beginning in 1825 ("mutualist" societies brought together workers who, in exchange for monthly dues, received aid in cases of sickness, strikes, or old age). Fourier's thinking (shaped in Lyon), socialism, and the first cooperative experiments in the 1840s, Proudhon's works on mutualism (beginning in 1845, then developed in *Du principe fédératif* [*Principle of Federation*], 1863; *Théorie de la propriété* [*Theory of Property*], 1866–1871), and Marx's critique of capitalism (the first volume of *Das Kapital* in 1867) constitute the groundwork, or at least the metaphorical (analogical) support for a new way of thinking about interactions among living beings: the dual nature of lichens was demonstrated in 1867 and mutualism was conceived in 1875.

Here, for comparison, are two definitions written by two Pierre-Josephs, the first, by Pierre-Joseph Proudhon, defining social mutualism (1871) and the second by Pierre-Joseph Van Beneden, defining biological mutualism (1875):

> A social system based on equal liberty, reciprocity, and the sovereignty of the individual over himself, his affairs, and his products; it is achieved through individual initiative, free agreement, cooperation, competition, and *voluntary association in view of defense against aggression* and the aggressor, and the protection of life, liberty and property of the non-aggressor.[27]

> Thus aid between animals is just as varied as that which is found among humans: some receive a place to live, others food, and others bed and board. We find a complete system of lodging and feeding, comparable to the best planned philozoic institutions. But if, alongside the poor, we see *others who mutually assist one another*, it would hardly be flattering to characterize

them all as parasites and commensals. We think it more just in their regard to call them *Mutualists.*[28]

This analogical thinking regarding symbiosis has been highlighted by the scientific and philosophical community: Maurice Caullery in 1922, then, more recently, Olivier Perru,[29] Mark-André Selosse,[30] and Brice Poreau.[31] In addition, I would say that new political theories and new ways of thinking (symbiotic, mutualist) about living beings have issued from the same socio-historic humus. They have come to counterbalance the view of nature as a place of competition and conflict and will continue to be intertwined and mutually supportive.

As early as the 1880s, this social dimension tended to create a gulf between symbiotic (mutualist) and evolutionary (cooperation versus competition) theorists, translating into the differences between their social (socialism and mutualism versus social Darwinism) and philosophical-political (communism versus capitalism) counterparts. Russian researchers, for example, developed a more cooperative vision of evolution.[32] Reintegrated into an evolutionist perspective, symbiosis can be caught between two opposing views: the theory of "symbiogenesis," according to which the fusion of two organisms into one is the driving force of evolution; and Darwinism, according to which organisms survive only through their descendants. This explains why the concept of symbiosis was neglected for so long in the twentieth century. It was not until the late 1970s that it was truly conceived as being in concert with evolution.[33]

Nevertheless, we must note the important pioneering efforts of Karl Fedorovitch Kessler (1815–1881), professor of ichthyology at the University of Petersburg, who, as early as 1879 (two years before his death), thought to nuance the Darwinian reading of evolution by showing even more radically the importance of mutual aid in animals, notably for reproduction: "Mutual support is as much a law of nature as reciprocal struggle is; but for the *progressive* evolution of the species, the first is more important

than the second."[34] This thesis had fundamental importance for Russian political thinker Pierre Kropotkine (1842–1921); it was the foundation for his definition of human societies and his thinking on anarchist socialism.

> The animal species, in which individual struggle has been reduced to its narrowest limits, and the practice of mutual aid has attained the greatest development, are invariably the most numerous, most prosperous, and the most open to further progress.[35]

On the micro-biological level, the works of US researcher Lynn Margulis (1938–2011), during the 1960s, revolutionized and generalized the approach to organelles (the microscopic constituents of cells), like mitochondria and chloroplasts. She proposed that the eucaryotic cells that contain them are actually the result of symbiotic associations with different procaryotes. For support she relied notably on the work of Russian researcher Constantin Sergeïevitch Merejkovski (1855–1921) from the years 1900–1910, involving the symbiotic origin of chloroplasts beginning from diatoms and lichens. Thus, in the same way that the algae of lichens could be "ancient" autonomous algae, the chloroplasts present in algae, that allow for capturing light for photosynthesis, could be "ancient" bacteria: multi-scalar symbiosis. According to Margulis, symbiotic interactions would thus be the driving force of evolution, through horizontal transfer of genetic materials between bacteria (or viruses) and eucaryotic cells.

In a century, thanks notably to scientific advances allowing for better examining and better understanding infinitely small microbial life, symbiosis has been observed and analyzed in increasingly numerous configurations extending to the whole of the living world; it has become the general rule, no longer the exception; a mode, no longer a revolution.[36] In 1974, with English chemist James Lovelock, Margulis formulated the "Gaia hypothesis," according to which the planet itself is one gigantic

organism functioning symbiotically, harmoniously self-regulating its components. "The whole world [...] like a giant lichen," wrote Thoreau.

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The thinking on symbiosis now extends into the natural sciences, genetics, philosophy, economy, anthropology, and the arts.[37] Everyone is taking it up. That's the case with the splendid spider webs of Argentinian artist Tomás Saraceno (born in 1973), or the installations entitled *Symbiotic Vision*, in the Zurich Kuntshaus beginning in 2020, by the famous Icelandic–Danish artist Olafur Eliasson (born in 1967), which play with interactive art to try to illustrate the idea of a world made of interactions: in one of the halls, a screen located on the ceiling reacts to the heat of human beings as they enter. Cutting-edge research is also being done now on other symbiotic fungi, the mycorrhizae, which are located on the roots of plants and create a whole network of sugar exchanges with their symbiotic partners. Symbiosis is thus revolutionizing our practices. With plants and human bodies alike being places of symbiotic cooperation, we are now rediscovering the advantages of "companion planting" (of "vegetable guilds") once familiar to our rural ancestors. This practice consists of growing many plant species (among them notably the infamous "weeds") on the same plot of land at the same time. Similarly, dietetics now likes to take into account our microbial makeup.

Such research is multiplying and more generally testifies to the current turn, a veritable "plant turn" in thinking (philosophic, anthropologic, artistic), a return to the limelight of the plant and fungal world. From the theoretical and biological perspective, this trend began at the turn of the millennium with the pioneering works of Francis Halle[38] and Patrick Blanc.[39] It has expanded over the last decade,[40] especially with the growing importance of fungi and mycorrhizae (mosses, as well, should not be left out).[41]

The concept of symbiosis has evolved; it has been expanded, re-rooted, and neutralized. In 1991, Lynn Margulis defined it

henceforth as "a set of [ecological] interactions between nonhuman organisms," involving physical proximity, different species, and significant duration.[42] The whole ensemble creates a new, complex unit that French insect biologist Paul Nardon named a "symbiocosm" in 1995.[43] It involves the "pooling" of two or many genomes toward the goal of ensuring survival and adaptation in the environment of the newly formed entity. That is to say that here we find again the original (etymological) and more general definition of Anton de Bary's "cohabitation." English lichenologist David Cecil Smith prefers the expression "mutual interdependence" which, as Olivier Perru has shown, "empties the collective imagination of idealizations of mutual aid and synergy."[44] Lynn Margulis has criticized the mutualist vision for its anthropomorphic projections, as if symbiosis involved a sort of social contract and cost-benefit analysis between organisms. Moreover, she shows that symbiogenesis does not happen without struggle or imbalance, sometimes resulting in the death or rejection of one of the symbionts.

In recent years, the notion of *mutualist* symbiosis has been deconstructed – or stripped of illusions – by the scientific community. In 2001, David C. Smith declared that the symbiotic exchange on a nutritive level is often unilateral: for one of the partners, the cost of symbiosis outweighs the benefits.[45] The fungus synthesizes an enzyme ("permease") that acts on the membranes of the algae to facilitate the diffusion of the sugars that they contain. Similarly, in the laboratory, if a fungus is provided with dissolved sugars, it tends to suffocate the algae, as if they were no longer necessary to it. Mycorrhization can also fluctuate between mutualism and parasitism over the course of time. In November 2013, a team of German and Mexican researchers published the results of a study on the relationship between the *Pseudomyrmex ferrugineus* ant and bullhorn acacia tree of Central America. The tree provides the ant with the only type of sugar that it can assimilate in exchange for its protection against plants and herbivores. According to their conclusions, the ant larvae secrete an enzyme

("invertase") that allows them to assimilate any type of sugar, but upon contact with the nectar of the acacia, they no longer produce it, as if the tree had rendered them dependent on its own sugar. Notably because of these enzymes, their symbiosis seems to be increasingly reduced to a form of parasitism, a "master/slave relationship," Schwendener would say. In *lichens*, there are *links*, but they come with all the ambiguity of "links," which unite but also enchain. Any partnership may be imbalanced. Symbiosis, which assumes an innate horizontality among living beings, is a space of convenient and fertile projections, which also tends to be relativized – at the same time as democratic models show increasingly unilateral or "parasitic" tendencies.

> The difference between you and Talita [...] is something that is obvious to the touch. I don't understand why you have to pick up her vocabulary. I'm repelled by hermit crabs, symbiosis in all its forms, lichens, and all other parasites.
>
> Julio Cortázar[46]

*

It may be a matter, then, of moving beyond the concept of symbiosis by returning to its original sense, void of mutualist meanings: a suspended relationship, without a defined status, beyond cooperation and competition. As David George Haskell has written in the magnificent pages that he devotes to lichen in *The Forest Unseen: A Year's Watch in Nature*, "We need a new metaphor for the forest, one that helps us visualize plants both sharing and competing."[47] And for that, we must no longer rely on the idea of the individual:

> The lichen partners have ceased to be individuals, surrendering that possibility of drawing a line between oppressor and oppressed. Like a farmer tending her apple trees, and her field of corn, a lichen is a melding of lives. Once individuality dissolves, the score card of victors and victims makes little sense. Is corn

> oppressed? Does the farmer's dependence on corn make her a victim? These questions are premised on a separation that does not exist. [...] Lichens add physical intimacy to this interdependence, fusing their bodies and intertwining the membranes of their cells [...] bound by evolution's hand.[48]

More than the nature of the symbiotic relationship, the most important thing may be this revision of the concept of the individual that symbiosis necessitates: the idea that living beings are porous, interdependent, open to "trans-species" and "trans-kingdom" alliances. Life is interstices. Life is *trouble* (Donna Haraway). Living is thus, essentially, a *politics*: the world as inter-species and interkingdom politics, like a "worldwide web" with moving, dynamic configurations, these networks participating in the evolution of the species.

Chimeras, Vampires, and Other Common Monsters

With its aberrant appearance and monstrous beauty, lichen is also a chimera.

In Greek mythology, the chimera is a monster composed of a patchwork body of different animal species. But chimeras are no longer chimerical: the lichen body is, among other things, part algae and part fungus or fungi, part plant and part fungus, part earth and part sea, at the crossroads of kingdoms and ecosystems; it is a conjunction of intensities.

Turning from a morphological to a genetic perspective, we can now speak of "chimeras" to describe organisms composed of distinct genomes: this is the special case of reproduction between different animal species or that of the plant graft, which brings together two plant species, each retaining its genome, within a single organism – and the ordinary case of lichen.

Lichen is like a "double star." It is generally perceived as a single body, but as soon as we look more closely, we see that the star we think we have distinguished in the night sky in reality hides two

Figure 14 © Pascale Gadon-González, *Biomorphose* (5110), 2019, with *Anaptychia* lichen, originally in color, Rome, Italy, pigment print, 30 x 40 cm.

stars (principals) in mutual orbit, each turning around the other (or more precisely, around an absent center – although one of the stars may be more powerful than the other).

*

Our own bodies cohabit with thousands of bacteria. It is estimated that more than twenty thousand different species live in us, and with us, and that ninety percent of the total number of cells present in our bodies are bacterial or fungal. "Our" body is an outdated concept. They live especially in surfaces exposed to the environment (skin, nose, small intestines, and colon).

The mechanism of symbiosis invites us to redefine the boundaries of biological individuality, as well as the limits of anthropology. Substances no longer exist.[49] The individual is neither unitary nor closed, but compound, divided, and in relationships with a symbiotic retinue at once mutualist (on the order of cooperation) and parasitic (on the order of competition). The evolution of the human species is the fruit of "lichenizations."

Although the discoveries of symbiosis date back centuries and, with regard to the human body, go back to the 1960s and 1970s, it is especially over the course of this last decade that philosophy has seized upon it. After the Anthropocene, the *Lichenocene*. We can observe a growing trend for applying the lichen metaphor to human beings: launched in March 2012 by US biologist David George Haskell ("we are lichens on a grand scale")[50] and in December 2012 by US biologist Scott Frederick Gilbert ("we are all lichens"),[51] it was extended, notably by French philosophers Olga Potot (in an inclusive version: "*Nous sommes tou-te-s du lichen*" [We are *all* (feminine and masculine forms) lichen] in 2014)[52] and Karine Prévot ("*Somme-nous des lichens? Une perspective végétale sur l'individu*" [Are we lichens? A plant perspective on the individual] in 2018),[53] and yet again by the famous US anthropologist Donna Haraway in 2016 ("We are all lichens, all corals").[54] Beginning with Donna Haraway's book, US artist Laura C. Carlson reflects radically on ethical and ecological, as well as feminist and decolonialist implications of this declaration with her 2018–2019 exhibition of a series of embroidered banners entitled *We Are All Lichen*.[55] Different species of lichens are represented, enlarged, "altered," and suspended vertically, appearing as so many flags advocating and imagining a way of thinking about relationship.

> I created ten banners featuring lichen "maps." In lichen maps, I can create points of clarity within the lichen, where species mingle, where they grow, and how they endeavor together.[56]

Like coral, lichen has the peculiarity of presenting individualized components within a single structure that is reproduced as such. It is an organism *formed* by symbiosis: this is not an acquired function but a *condition* of growth. According to Karine Prévot, "that is how the question of individuality [...], and the question of symbiosis that it brings to light, clear the way toward a conception of individuality open to communities and ecosystems as a whole."[57]

The vertical and determinist vision of genetics, inherited from the twentieth century, is thus outdated. Recent research is headed in this direction: the symbiotic environment plays a role in the genetic makeup of an individual. Genes are not simply innate, some can be acquired through transfers of symbiotic partners. The Darwinian theory is thus being reevaluated; evolution is no longer linked to the individual struggle for survival, but to relational configurations that can be its driving force, as we have seen. Survival is no longer that of the fittest, but the result of the most effective interactions.

In this context, existence precedes essence; we define ourselves by our choices, but also involuntarily by our relationships with our companion species, our "symbionts." Essence is thus a shifting, relational, and ecological notion. The individual is only "the visible foam of a microbial world," Marc-André Selosse insists poetically.[58] The unicity of the pronoun "I" that designates "me," the human speaking self, which was demolished on the philosophical, psychological, and linguistic planes beginning in the nineteenth century, was something poetry had long questioned. Let us recall Rimbaud's now famous line from 1871: "I is another." Modern poets sought to alter the "I" and open it to the "you," to create a polyphony and a theatricality deconstructing the "I" into a precarious role. "I was born full of holes," wrote Michaux in 1929. This time, its unicity is being contested on the biological plane. The "I" is fundamentally open to its symbionts, a sort of fourth human "narcissistic wound," to adopt Freud's expression (the earth is no longer the center of the universe, human beings are no longer the exception among living beings, nor the "sovereigns" of their souls, nor, henceforth, of their biology).

*

Until now, not many artists have played with the metaphor of lichen's symbiosis to formulate the modern idea of a language that no longer comes only from a single subject but is an organization, an ecosystem. Montaigne characterized his essays as "chimeras." In

his *Troisième Dessous* (1977), Michel Butor considers the practice of intertextuality, of textual dialogue, as a "symbiosis."

This work is made up of dreams that are visual homages to painter friends. Lichen is thus ideal for the title of the one dedicated to Saby ("The Dream of Lichens"). But more generally, Butor defines the writing in these homages, which are art critiques based on encounters between Butor's language and that of the artists in question, as a "compenetration" of styles. This intertextual practice, which involves integrating the voice of the other with one's own voice, sometimes violently, is described as a sort of "vampirism." But this act is reciprocal (the two speakers are vampires): the vampire transforms the dead even while transforming himself, in a mutual revival. This image makes me think of the "anthropophagia" movement in Brazilian modernist literature, which consisted of devouring texts to better appropriate them, to be transformed by transforming them, and *vice versa*. Butor evokes the concept of symbiosis in this way:

> "The Dream of Lichens" is a text in which I integrated an interview with a painter of my friends. And, by transforming a certain number of terms in the text of the interview, I obtained a species of vampire conversation, with all sorts of branching, to try to create a text that was itself a sort of lichen, lichen being, for me, in this whole thing, the very image of symbiosis, that is, collaboration. All these texts, made beginning from works of painters, are lichens. *Organisms that compenetrate,* to arrive at these *configurations* of lichens.[59]

This polyphony materializes in the play between italics and regular typeface, between prose and poetry. This fragmentation of the writing and how it occupies the page can call up the visual image of lichens on their supports. Butor evokes this idea a year later:

> with my entomological tweezers to thus isolate
> on the white pages gradually darkened by my glosses

a few of your iodized ink spots (September
the dahlias in the gardens classes about to begin again
and all the buzzing difficulties of this year
of the unexpected
Marie-Jo returns the car the trunk already empty)
like yellow and gray lichens on the granite
[...]
pages
lines thighs and time
spots lichens[60]

The organic model for describing the way text functions is not new, but the symbiotic model is. It allows a dialogic ideal, both intertextual and intermedium, to be formulated, permitting reciprocal "transits" between two artists united in the ecosystem of the page.

A "Third Place"

The nineteenth-century concept of "symbiosis" (the "algo-lichen hypothesis") made it possible to describe the double nature of lichen, observed on the microscopic level. It allowed for the transition from a unified and universal concept of the biological individual (the "lichen being") to a plural and shifting definition, an ensemble of parts.

This deconstruction of lichen has resulted in its fragmentation into something like building blocks. There are the fungus, algae, yeast, and microbes that cohabit in the same structure, each with its own specialist in the scientific world. This interpretation, though necessary for better understanding lichen, has had the gradual effect of favoring the perspective of the fungus. The lichen is supposedly only a "nutritional strategy" for the fungus, a "fungal intention" in the same way as other fungi might cohabit with tree roots or decomposing matter. In 1961, this *reductionist* positioning, made possible by the microscope, resulted in the

4 Toward a Symbiotic Way of Thought

1 Symbiosis was conceived in the nineteenth century essentially beginning with two models coming from fungi: lichenized fungi and mychorrhizea .

2 Selosse, *La Symbiose*, p. 5.

3 Ibid., p. 134.

4 Stephen Collis, Canadian poet, activist, and academic, reflects on this idea in his writings, notably in *To the Barricades* (Vancouver: Talonbooks, 2013).

5 *Datableed* 3 (2015) (https://www.datableedzine.com/drew-milne-lichens), then in, Drew Milne, *In Darkest Capital: Collected Poems* (Manchester: Carcanet Press Ltd (2017), section "Lichens for Marxists."

6 Karl Friedrich Wilhelm Wallroth, *Naturgeschichte der Flechten* (Frankfurt am Main: Bey Friedrich Wilmans, 1825–1827).

7 Simon Schwendener, 'Untersuchungenüberden Flechten-thallus', in *Beiträge zur wissenschaftliche Botanik* 4 (1868), pp. 195–207.

8 Albert Bernhard Frank, *Über die biologischen Verhältnisse des Thallus einiger Krustenflechten, Beiträge zur Biologie der Pflanzen* [On the biological conditions of the thallus of certain crustose lichens] (1877), vol. 2, pp. 123–200 [italics mine].

9 This definition of symbiosis is found in *Die Erscheinung der Symbiose* [*The Appearance of Symbiosis*], translated into French in 1879. Oliver Perru and Marc-André Selosse stress that Anton de Bary no doubt adopted Albert Bernhard Frank's term, whom he knew and whose works he admired, as their universities were in the same vicinity (contrary to a version of history that makes Anton de Bary the inventor of the word). Whatever the case, the development of this concept was concomitant and clearly shared by these two researchers.

10 Ernst Haeckel, *Generelle Morphologie der Organismen* [*General Morphology of Organisms*] (Berlin: Georg Reimer, 1866).

11 Chantal Van Haluwyn, 'La symbiose lichénique: un partenariat

difficile à démasquer', *Bulletin de l'Association française de lichénologie* 45:2 (November 2020), p. 158.

12 David Leslie Hawksworth and Martin Grube, 'Lichens redefined as complex ecosystems', *New Phytologist* 227:5 (2020), pp. 1281–1283.

13 "Regarding the term itself, it was used for the first time and in a political sense by the Greek historian Polybius, in the second century BCE." (Olivier Perru, 'Aux origines des recherches sur la symbiose vers 1868–1883', *Revue d'histoire des sciences* 59: 1 (2006), p. 18, note 52).

14 The word "cryptogam," used to designate the family to which lichens belong, means in ancient Greek, "hidden marriage," "hidden birth" (because their reproduction is invisible to the naked eye).

15 I have found no evidence of a single scientist who mentions this.

16 This is in Volume 14 of his *Moral Essays.*

17 [Italics mine]. In ancient Greek: "ἀλλὰ μᾶλλον ἐπὶ τὰς κατ' ἰδίαν κοινωνίας αὐτῶν καὶ συμβιώσεις ἰτέον."

18 See especially an extract from Chrysippus' *Ten Treatises on the Honorable and on Pleasure*, cited by Athenaeus of Naucratis (*Deipnosophistea*, 3, 38, 89d).

19 Plutarch, *De Sollertia Animalium* 30, trans. William W. Goodwin et al., in *Plutarch's Morals* (Boston: Little, Brown and Company, 1878), vol. 5 [italics mine].

20 In 'Apologie de Raymond Sebond' [An Apology for Raymond Sebond], (*Essays* 2, 12), very much inspired by Plutarch, Montaigne mentions various examples of symbiosis: those "particular offices that we draw from one another, for the service of life."

21 Ambroise Paré, *Opera Ambrosii Parei* 24, 'De monstris et prodigiis' (Paris: Jacob du Puys Éditeur, 1582), p. 781 : "Chrysippus Solensis in *de Honest. & volup.*: Pinna & pinnoter operas *mutuas* praestat, seorsum vivere non possunt" [italics mine]; this case is mentioned just after that of the hermit crab.

22 Theophratus, *Enquiry into Plants and Minor Works on Odours and Weather Signs*, trans. Sir Arthur Hort (Loeb Classical

Libarary, London: William Heinemann, New York: G.P. Putnam and Sons, 1946), vol. 5, 2, 2, p. 105 [italics mine]. This is no doubt a reference to grafting, which we also find in Pliny (*Natural History*, Book 17, ch. 24, 101). Speaking of the discovery of grafting [*coitum*], he writes: "A careful husbandman, being desirous, for its better protection, to surround his cottage with a palisade, thrust the stakes into growing ivy in order to prevent them from rotting. Seized by the tenacious grasp of the still living ivy, the stakes borrowed life from the life of another wood, and it was found that the stock of a tree acted in place of earth." (trans. John Bostock, Henry T. Riley [London: Henry G. Bohn, 1856]).

On line: http://www.perseus.tufts.edu/hopper/text?doc=Perseus:text 1999.02.0137:book=17:chapter=24&highlight=ivy

23 The revolution in scientific knowledge brought about by revolutionary nineteenth-century technology cannot be emphasized enough. Those advances allowed for the discovery of lichenic symbiosis as well as an understanding of how certain diseases work and the implementation of vaccines, for example. Currently, we are witnessing a new revolution, involving the study of lichens, thanks to progress in genetic analysis.

24 On this subject, see the very beautiful edition of an extract from the *Théorie de l'unité universelle*, entitled *La Botanique passionnelle* (Vichy: La Brèche, 2017).

25 Charles Fourier, *Traité de l'association domestique-agricole* (Paris and London, 1822), p. 499.

26 Van Beneden, *Les Commensaux et les parasites dans le règne animal*, p. 3.

27 Pierre-Joseph Proudhon, *Théorie de la propriété* (posth.) (Paris: Flammarion, 1871) [italics mine].

28 Van Beneden, *Les Commensaux et les parasites dans le règne animal*, pp. 10–11 [italics mine].

29 "It is interesting to see that J.-P. Van Beneden, professor in Leuven, based his whole approach to interrelationships in the animal kingdom [...] on analogies with human societies." Olivier

Perru, *De la société à la symbiose: Une histoire des découvertes sur les associations chez les êtres vivants [1860–1930]* (Paris: Vrin, 2003).

30 "Biological mutualism is thus in part the avatar of philosophical and political thinking that believes in the solidarity of altruism, at the risk of anthropomorphism and finalism when it is projected onto biology. [...] The concept of biological mutualism emerged in the era when workers unionized into "mutualities" for mutual protection from the hazards of existence." Marc-André Selosse, 'Symbiose et mutualisme *versus* évolution: De la guerre à la paix?', *ATALA*, "Pour une biologie évolutive," 15 (2012).

31 The thesis that biological mutualism is rooted in the political ideology of the period was developed especially in the 1980s and 1990s by Douglas H. Boucher (*The Biology of Mutualism: Ecology and Evolution* (New York: Oxford University Press, 1985), pp. 13–14) and by Jean-Marc Drouin (*L'Écologie et son histoire* (Paris: Flammarion, 1993)), to locate them in this specific context. In his thesis (*Biologie et complexité: Histoire et modèles du commensalisme*, directed by Olivier Perru, University of Lyon- I (2015), pp. 231–236), Brice Poreau adds nuance to the question of how directly the political influenced the biological in the thinking on mutualism, with evidence from his meticulous study of Van Beneden's archives. Poreau focuses particularly on this scientist, while simultaneously demonstrating the importance of the concept in the history of biology.

32 See on this subject, Daniel Todes, 'Global Darwin: Contempt for competition', *Nature* 462 (2009), pp. 36–37; Marc-André Selosse, 'Symbiose et mutualisme *versus* évolution: De la guerre à la paix?', article cited above, note 30.

33 The works of Lyon researcher Olivier Perru are illuminating with regard to the archeology of associative thinking on living beings beginning in the 1860s, the reinterpretation of the theory of evolution, and the contribution of genetics: ***De la société à la symbiose: Une histoire des découvertes sur les associations chez les êtres vivants [1860–1930]*, 2 vol. (see note 29 above).**

34 Karl Fedorovitch Kessler, "On the Law of Mutual Aid," speech given in December 1879.

35 Pierre Kropotkine, *Mutual Aid: A Factor in Evolution* (London: William Heinemann, 1902).

36 See on this subject, the works of French botanist and symbiosis specialist Marc-André Selosse, *Jamais seul: Ces microbes qui construisent les plantes, les animaux et les civilisations* (Arles: Actes Sud, 2017); and of French researcher in evolutionary biology Éric Bapteste, *Tous entrelacés: Des gènes aux super-organismes : les réseaux de l'évolution* (Paris: Belin, 2018).

37 Let us think, for example, of the book by Pablo Servigne and Gauthier Chapelle, *L'Entraide: L'autre loi de la jungle* (Paris: Les Liens qui libèrent, 2017). *Mutual Aid: The Other Law of the Jungle*, trans. Andrew Brown (Cambridge: Polity Books, 2022).

38 See Francis Hallé, *Éloge de la plante: Pour une nouvelle biologie* (Paris: Seuil, 1999), and *Plaidoyer pour l'arbre* (Arles: Actes Sud, 2005).

39 Patrick Blanc, *Être plante à l'ombre des forêts tropicales* (Paris: Nathan, 2002).

40 There are, among others, the outstanding works by David George Haskell (*The Forest Unseen: A Year's Watch in Nature*, 2012), Stefano Mancuso (*The Revolutionary Genius of Plants*, 2013), Michael Marder (*Plant-Thinking: A Philosophy of Vegetal Life*, 2013), Eduardo Kohn (*How Forests Think: Toward an Anthropology Beyond the Human*, 2013), Anthony Trewavas (*Plant Behavior and Intelligence*, 2014), Peter Wohllenben on the subject of mycorrhizae (*The Hidden Life of Trees*, 2015, a best-seller exploring the networks of cooperation and communication of root systems in forests), Anna Lowenhaupt Tsing (*The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*, 2015), Natasha Myers (who proposed the idea of a "phytocene age" in 2016, and, evoking photosynthesis, emphasized that it is plants that "make the world"), Jacques Tassin (*What do Plants Think About?*, 2016), Emanuele Coccia (*The Life of Plants: A Metaphysics of Mixture*, 2016), Marc-André Selosse

(*Jamais seul: Ces microbes qui construisent les plantes, les animaux et les civilisations*, 2017), Jean-Baptiste Vidalou (*Être forêts*, 2017), and Eric Bapteste (*Tous entrelacés: Des gènes aux super-organismes: les réseaux de l'évolution*, 2018). Listed here are the publication dates of the texts in translation or in their original languages. Let us note that in October 2020, The Fungi Film Festival, the first international festival of short films devoted to fungi, was held on a mushroom farm in Portland, Oregon in the United States, and viewed on line internationally.

41 Let us mention *Gathering Moss: A Natural and Cultural History of Mosses* (2003) by Robin Wall Kimmerer of the United States, *Mosses, My Dear Friends* (2011) by Hisako Fujii of Japan, *Louange des mousses* (2012) by Véronique Brindeau of France, and *Moss: From Forest to Garden: A Guide to the Hidden World of Moss* (2016) by Ulrica Nordström of Sweden.

42 Lynn Margulis, 'Symbiogenesis and symbioticism', in Lynn Margulis and René Fester (eds.), *Symbiosis as a source of evolutionary innovation* (Cambridge: MIT Press, 1991), pp. 1–14 (p. 4 for the citation).

43 Paul Nardon, 'Rôle de la symbiose dans l'adaptation et la spéciation', *Bulletin de la Société zoologique de France* 70:4 (1995), pp. 397–406.

44 Olivier Perru, 'Aux origines des recherches sur la symbiose vers 1868–1883', *Revue d'histoire des sciences* 59:1 (2006), p. 18, note 52.

45 David C. Smith, 'Symbiosis research at the end of the millennium', *Hydrobiologia* 461 (2001), pp. 49–54.

46 Julio Cortázar, *Hopscotch*, trans. Gregory Rabassa (New York: Random House, 1966), p. 236.

47 Haskell, *The Forest Unseen*, p. 228.

48 Ibid., p. 3.

49 Emanuele Coccia, *Metamorphosis*, trans. Robin Mackay (Cambridge: Polity, 2021), p. 3.

50 Haskell, *The Forest Unseen*, p. 5.

51 S.F. Gilbert, Jan Sapp, A.I. Tauber, 'A symbiotic view of life: We

have never been individuals', *Quarterly Review of Biology* 87 (2012), pp. 325–341.

52 Olga Potot, "Nous sommes tou·te·s du lichen' : Histoires féministes d'infections trans-espèces', *Chimères* 82:1 (2014), pp. 137–144.

53 Karine Prévot, 'Sommes-nous des lichens? Une perspective végétale sur l'individu', *Critique* 850: 3 (2018), pp. 204–213.

54 Donna J. Haraway, *Staying With the Trouble : Making Kin in the Chthulucen* (Durham: Duke University Press, 2016), p. 72.

55 Since January 2021, fungi and lichens are even more present in the artistic world and this slogan even more fashionable. Of course this sometimes indicates an idealization of lichenic symbiosis, a kind of perfect mutualism appearing as a new ethical horizon. I have come upon it in exhibitions, like at the Brazilian Museum of Sculpture and Ecology in São Paulo in a series of flags done in 2020–2021 by Joana Amador and Mariana Lacerda. Entitled *Little Demonstration*, they offer variations on the theme of struggle ("Struggle like lichen," "Struggle like coral," "Struggle like a refugee," and so on) and point the artistic installation toward a street demonstration, in line with Laura C. Carlson. In the Kirchner Cultural Center it appears in the title of a sculpture by Romina Orazi (born in 1972): *Mundos sobre rastros, todos somos líquenes* (2021) represents a human being in cement covered with fruticose lichens and holding a plant.

56 Artist statement on the website : artpark21.org/.

57 Karine Prévot, 'Sommes-nous des lichens? Une perspective végétale sur l'individu', p. 211, article cited above note 53.

58 Marc-André Selosse, *Jamais seul: Ces microbes qui construisent les plantes, les animaux et les civilisations* (Arles: Actes Sud, 2017).

59 *Voyage avec Michel Butor*, interviews with M. Santchi, p. 185 [italics mine].

60 Michel Butor, *Illustrations* (Paris: Gallimard, 1976).

61 Gilbert Simondon, *Individuation in light of notions of form and information*, trans. Taylor Adkings (Minneapolis: University of Minnesota Press, 2020), p. 201.

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