Plant Societies

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It is the perfect narrative: ancient legends and mysteries handed down only by obscure shamans, primordial gods and universal mothers, food transported over long distances on underground paths unknown to most. What is more, it also involves the revenge of universal altruism over egoism, of the natural community and cooperation over subjugation and competition, or the Darwinian struggle for survival. However, this narrative has a much more solid and scientifically based start than anthropological propositions, i.e., from controllable experiments, using radioactive markers, and with perfectly reproducible results, in the pure tradition of western science, with the official stamp of confirmation in a paper published in 1997 in the prestigious journal *Nature*[1] (and this time it is true). The author of the paper that started it all, Suzanne Simard, is a Canadian biologist, Professor of Forest Ecology at the University of British Columbia. She was born and raised in a family of loggers, but don't imagine a cabin in the woods. The family has a company that works in the immense forests of the Canadian West. In the article, Simard states that she has demonstrated how nutrients – sugars and complex molecules – pass from one large, healthy plant to others that are nearby, but smaller or younger, and less healthy. Perhaps these smaller plants could still be growing, almost overwhelmed by the shade of the forest, or it might be autumn, when they lose their leaves and have the greatest need for nutrients. The donor plant might not necessarily be of the same species as the recipients. On the contrary, Simard's initial experiment traced the passage of nutrients from Douglas firs (*Pseudotsuga menziesii*) to birches (*Betula papyrifera*). In summer, when the small firs were shaded, nutrients flowed from the birch to the fir. In autumn, when the fir was growing (with evergreens, the growth of gymnosperms is continuous) and the deciduous birch lost

[1] Suzanne W. Simard et al. Net transfer of carbon between ectomycorrhizal tree species in the field. *Nature* volume 388, pages 579-582 (1997). https://doi.org/10.1038/41557.

its leaves, the flow reversed. The step from data to scientific explanation was relatively short, but revolutionary. According to Simard, there was only one way that the passage of molecules could take place: through the very dense and almost invisible network of fungal filaments that envelop the roots of many species of trees and grasses, the mycorrhizae. The concept of the network also immediately suggested to the scientific journal an analogy with THE NET, i.e., Internet. And in harmony with the *World Wide Web*, this hypothesis was named *Wood Wide Web*. The paper was soon widely confirmed. Other researchers varied the experimental conditions, changed the species involved (Aleppo pines and oaks, for example)[2], and also delved into the species of fungi acting as vectors of the molecules involved in the passage of nutrients. Scientific articles appeared, often in excellent journals, with conclusions that confirmed Simard's results and revolutionised all previous scenarios.

Not only scientific debate

From the point of view of theoretical interpretation at least, the actors in the drama were already present and well known to botanists. That the roots of many species of trees were enveloped in a network of almost invisible fungal filaments, and that these filaments were shared with other nearby trees is certainly nothing new – it has been known for many decades. According to Renzo Motta, Professor of Forestry at the Department of Agricultural, Forestry and Food Sciences at the University of Turin, "The processes of exchange between trees and anastomosis of the roots of plants in the same group have been known for a hundred years".[3] It did not surprise anyone to learn that between fungi and trees there was an exchange of complex molecules that acted as mutual nourishment (see the article *Intelligent Trees* in the October 2024 post of the *Balzan Digital Papers*, Intelligent Trees - Essay by Marco Ferrari). However, it did surprise everyone a little to learn that these same filaments were a conduit for the transmission of compounds between different trees in the forest. After this beginning, Simard helped to create and nurture metaphors far beyond forest ecology,

[2] Shifra Avital, Ido Rog, Stav Livne-Luzon, Rotem Cahanovitc, Tamir Klein. Asymmetric belowground carbon transfer in a diverse tree community. *Molecular Ecology*. no. 31, pages 3481-3495 (2022). doi: 10.1111/mec.16477.

[3] Interview by the author.

however. She disseminated her research in books,[4] lectures (like her famous Ted Talk)[5] and interviews in which she got her message across with very convincing language. For example, she realised that in a forest all trees were equal, but some were more equal than others. They were huge, imposing, and the network of fungi connected them to plants that were even very far away. Simard called them "mother trees". Without them, she said, the forest grows more slowly and becomes stunted. These mother trees are the ones who nourish the shoots of the new seedlings, and without them the forest struggles. These trees were not necessarily females, but it was the definition as "mothers" that helped create a fascinating picture. Thus, there were all the ingredients for the explosion of a powerful modern narrative and, at the same time, of controversy with other forest researchers, or industrial foresters, who were immediately classified as traditionalists and dullards by the "heretics". Those who exploited forests as a source of income, and who had daily experience with how they function, for example, challenged Simard on the weakness of her experiments and the difficulty of making the results fit in with their often centuries-old experience. Pure scientists, on the other hand, could not make these results conform to the classical (and very robust) evolutionary and ecological theories. The evolutionary scientists, the same ones with whom Simard had collaborated until recently, said that their approach was to clear-cut and replant, typical of the Canadian West, where the forests of British Columbia cover the mountains. After cutting the trees by chain saw or much more impactful tools, the barren slopes were repopulated with rows and rows of fir trees as "clean" and close together as possible, often free of root fungi. They grew rapidly and were harvested like wheat in the fields, but with a frequency of several decades instead of annually. From her experiments, Simard derived another method, which involved leaving at least the mother trees in the field. However, the foresters pragmatically rebutted that the mother trees were in the way and took up space, making them lose income. And finally, they were sure that it was not true that the forest would grow worse without them.

[4] Suzanne Simard, *Finding the Mother Tree*, Allen Lane (2021). Italian translation *L'Albero Madre*, Mondadori, translated by Silvia Albesano, (2023).

[5]https://www.ted.com/talks/suzanne_simard_how_trees_talk_to_each_other?subtitle=en&lng=it&geo=it.

A fascinating metaphor

Beyond the more strictly scientific or economic spheres, to which we will return, other circles have appropriated the concept of the "mother-tree", passing, however, somewhat surreptitiously, from metaphor to reality. The idea was thus immediately blown out of proportion by other exponents, placed in other contexts and used for the creation of metaphors that were often difficult to handle. Politics, philosophy, the figurative arts, cinema, and literature have all used Simard's vision to create content, to articulate political and economic theories, to paint frescoes of worlds in which the "mother individual" is present and central, and the scientific message adorned with traces of New Age. Accordingly, there are films (and television series) and paintings, novels and political or social essays that glorify Simard's insights. The concept of the mother tree has inspired James Cameron, the director of the film *Avatar* (2009), or Richard Powers, author of the novel *The Overstory*, not to mention the sector of the world of nature conservation that sees the research of Simard and others as scientific support to stop using slash-and-burn and especially herbicides between plantations. Suzanne Simard has also repeatedly insisted that her research goes in the direction of greater respect for ecosystems and the integrity of forests. The appeal of this approach is unquestionable, not only from a scientific point of view but also from a cultural one in general.

First doubts

To return to the strictly scientific sphere, theorists of evolution and forest ecology were, on the other hand, perplexed for several reasons, both practical and theoretical. After the first scientific articles confirming the transfer of nutrients from one plant to another, some researchers questioned whether Simard's measurements were robust enough to demonstrate this traffic. Indeed, the use of radioactive markers revealed that the percentage of nutrient molecules transferred was very low compared to the total, and did not reach 10%, which was too little to serve as a food reserve for the acceptor trees. Even in recent years, doubts have arisen about the data itself. The opinion of David Tilman, a US ecologist who teaches at the University of Minnesota and the University of California, Santa Barbara, and winner of the 2014 Balzan Prize in Plant Ecology, is stark: "The memory I have of this work on tree communication and nutrient sharing is that it was more of a romantic vision than a conclusion that can be drawn from a thorough analysis of the available data". Michela Audisio, a post-doc at the

University of Göttingen, where she studies the function of mycorrhizae as sources of nutrients for trees, explains: "There tends to be a positive view in the debate of plants exchanging nutrients and information, but there is little evidence of this".[6] It is, again, transfer that is the most critical point. Audisio states: "It is very difficult to prove that this carbon is transferred from one plant to another precisely through mycorrhizae. There could be other mechanisms that explain the phenomenon, such as diffusion through the soil", without resorting to concepts such as "plant will" or targeted reciprocal exchanges between different species. Another scholar of the biology of mycorrhizae, Justine Karst, Associate Professor at the University of Alberta, Canada, gave her article in the journal *Nature Ecology and Evolution* (August 2023) the even more decisive title "Positive citation bias and overinterpreted results lead to misinformation on common mycorrhizal networks in forests".[7] Karst does not hide her deep scepticism, clarifying that in the *Nature* article, she had pointed out problems with Simard's research as well as her having falsified the results in her book *Finding the Mother Tree* ".[8]

Comparing theories

Moreover, from a theoretical point of view, the transfer of nutrients from one tree to another does not fit into an evolutionarily "classical" worldview, in which competition – when not pure egoism – is the rule. Simard's hypotheses obviously go against a representation of nature as "red in tooth and claw"– as Tennyson put it in 1850,[9] nine years before Darwin's *Origin of Species.* Simard replaces the continuous and constant struggle for life (the most common, if simplistic image of evolution, derived from the subtitle of Darwin's classic book), with collaboration between different species, mutual and disinterested help between plants even of different ages. She creates the image of a forest where it is not ruthless competition between individuals that governs ecological and evolutionary dynamics, but the limitless sharing of

[6] Interviews by the author.

[7] Justine Karst, Melanie D. Jones & Jason D. Hoeksema: *Positive citation bias and overinterpreted results lead to misinformation on common mycorrhizal networks in forests*. Nature Ecology & Evolution, Volume 7 (2023), pages 501-511. https://doi.org/10.1038/s41559-023-01986-1.

[8] Interview with the author.

[9] In Memoriam A. H. H.: 56 by Alfred Lord Tennyson - Famous poems, famous poets. - All Poetry.

resources. The position is thus almost entirely opposite to that of Darwinian orthodoxy, at least the one that was dominant from the 1930s to the 1960s/70s. In the last few decades, in fact, new ideas and hypotheses have made their way in, highlighting how competition and egoism (in the scientific sense, without value judgements) were indeed present in many of the ways living species behaved, but not in such a constant and omnipresent manner as was once thought. Overcoming egoism (which had actually been proclaimed decades earlier by other thinkers[10]) thus led to much more complex and articulated evolutionary dynamics, in which out-and-out individualists and profiteers did not have an easy time. Whoever collaborated was more integrated in society and enjoyed the benefits. For evolutionists, however, Simard seemed to exaggerate from the other side, portraying plant society as totally dedicated to disinterested collaboration, not only between individuals, but also between different species. Even with the abovementioned revisions, evolutionists said that pure and simple altruism, in which the giver loses something and only the receiver benefits, does not exist in nature. There is always, in one way or another, self-interest, which one might even call selfishness. Theoretical considerations and decades of careful observation of the behaviour of plants and animals had come to this conclusion, almost a mantra for biologists dealing with evolution. Audisio remarks: "In nature, both mechanisms, competition and cooperation, coexist. It is more likely that the whole is a continuum, without the need to focus on one or the other". Another detail made the picture even more complex: mediating this exchange between two species was another "biological entity", namely fungus, the channel through which molecules pass. These species in turn have "selfish" and, again, "personal interests". Functioning only as a method of transmission brings the fungus no returns: this behaviour, too, does not seem compatible with the dominant evolutionary theory. To complicate matters, mycorrhizal fungi have a double identity: "They can be beneficial, and establish a mutualistic symbiosis with trees, but some of them can take advantage of the plant's precarious state of health and become pathogenic", Audisio concludes.

[10] For example, Piotr Kropotkin, *Mutual Aid: A Factor of Evolution* (McClure Phillips & Co, 1902). translated by Camillo Berneri (1925).

An increasingly complex theory

As almost always happens in scientific disputes, the reactions from Simard and others who found similar results were on the one hand emotional, and on the other more in keeping with a discussion based at least in part on research in the field. As previously mentioned, the initial article produced other contributions that reinforced Simard's position, and those who had doubts were labelled as "backward looking" or "bound to an old theory" – which is partly true, because as we have seen, the view of nature as the realm of selfishness is relegated to a few decades ago. On the side of "official" science – apart from harsh judgments, Simard's research actually also uses the same scientific methods – discussions now focus on more technical aspects, for example, on the fact that thinking that "mother plants" favour their own offspring (one of the accessory hypotheses) does not seem to be proven. As Renzo Motta says: "The idea that the plant nurtures its seedlings (i.e. the seedlings born from the seeds, ed.) is completely false. Plants produce, some more, some less, substances that inhibit the other plants from taking root (allelopathic), especially if they are relatives". This is because the original tree would face strong competition even from its own offspring, which is anything but "logical" from an evolutionary point of view.

Plants and human societies

In addition to the scientific aspects, there are many others to be considered in the discussion – political and social worldviews, for example. Feminist approaches, perhaps the most interesting, or theological suggestions use Simard's ideas as a basis for their own visions of society. Social forests thus become metaphors for human society, even if this rhetorical figure is not always used properly. Others have been also inspired by them to explain, through the altruism of trees, positions to be transferred to the politics of our species. Co-operation (between plants) would thus be at odds with the typical neo-liberalism (of human politics) of recent decades. Of course, no one seriously goes so far as to say that we must follow the example of the members of the plant kingdom, but a political position is explained and justified by an interest in forced cooperation,[11] just as Simard's

[11] Rob Nixon, *The Less Selfish Gene: Forest Altruism, Neoliberalism, and the Tree of Life*, Environmental Humanities November 2021, Vol. 13, No 2: pages 348-371. https://doi.org/10.1215/22011919-9320189

theories/hypotheses are thought to run counter to classical Darwinian evolutionary theory, which in turn originated in the climate of Victorian England, the age of classical liberalism. Here, too, there was no lack of criticism, even on particular points, which Simard holds dear. As mentioned above, Simard explained, for example, that her position should also be used to push for the protection of forests, but many environmentalists believe that using "dubious" data and experiments is the wrong approach. This is because, from a philosophical point of view, the whole theory is flawed by anthropocentrism: that is, wanting to attribute to plants aspects that we know to belong more to animals, even those as complex as humans. Characteristics such as altruism, sociality, mutual aid, willingness, conscious choice and others, according to an article published earlier this year, are "perils of plant personification".[12] The authors state that:

> *The origin of this concept seems to stem from a desire to humanise plant life but can lead to misunderstandings and false interpretations and may eventually harm rather than help the commendable cause of preserving forests.*[13]

Cleansed of New Age and spiritualistic drifts, it is likely that Suzanne Simard's scientific findings can be very useful for a new perspective on botanical studies, and the discussion will prove fruitful with time. It is, of course, perfectly legitimate to draw inspiration from this research for books, film or theatre scripts, novels, podcasts or whatever. But to draw on scientific results that are still weak in order to derive a new worldview from them and suggest anthropological, social, political or other proposals, or to rely on these same results for a (much-needed)

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[12] David G. Robinson et al, *Mother trees, altruistic fungi, and the perils of plant personification*, Trends in Plant Science, January 2024, Vol. 29, No. 1. https://doi.org/10.1016/j.tplants.2023.08.010. The article also sharply criticises Peter Wohlleben's book of 2015 *Das geheime Leben der Bäume* (Ludwig Buchverlag; transl. it *La vita segreta degli alberi*, Macro Edizioni, 2022). The authors explain: "Since the information base of Peter Wohlleben's writing is a mix of a few selected paragraphs from scientific articles combined with press releases and websites, one finds few clear factual statements. Yet, some of the cornerstones of his perspective on forests are completely baseless assertions".

drive for the conservation of nature, is considered by many scientists to be premature at the very least if not, as some peremptorily assert, downright incorrect.