QUOTATIONS FROM HUGO SCHANDERL

IN: Pommeresche, H., 2014, Humusphere, Humus: a Substance or a Living System, translated by Paul Lehmann, 284 p.

I would like to conclude by leaving you with some important quotations from Hugo Schanderl (1964) that act as a short, easily understandable summary of what I hoped to convey with this book (the most important passages are highlighted in bold): **"On the emergence of bacteria from plant cells.**

"I dedicated an entire chapter of my 1947 book *Botanische Bakteriologie auf neuer Grundlage* [*A New Basis for Botanical Bacteriology*] to the subject of the bacteria in the soil. The 'new basis' alluded to in the title was the discovery, supported by plentiful experimental proof, that the old idea of 'internal sterility' in the higher plants was mistaken. **I have devised and described many methods and experimental designs that all pointed in the same direction, toward the same result,** namely that fully viable germs can emerge from plant tissue in a form we've long known of and is found all over—bacteria.

"Every modern discovery in molecular biology has supported the idea that mitochondria evolved from bacteria. In many plants, they can still be transformed back into autonomous, culturable bacteria through relatively simple methods. Even larger organelles such as plastids evolutionarily originate from bacteria and can turn back into them under experimental conditions. Most striking of all is the transformation of chlorophyllgenerating chloroplasts back into bacteria: the very first bacteria that emerge from them are still visibly green during their first hours of life. The entire process of the remutation of chloroplasts into their original evolutionary forms is 'color coded' by nature. **This disproves the objection that the appearance of the bacteria in this experiment might somehow have been a result of outside infection.**

"The death of a plant gives rise to billions of new lives through the transformation and remutation of organelles into their earlier evolutionary form—bacteria.

"When plant parts or whole plants are buried or composted in the soil, the lives of the particular plants or plant organelles come to an end, but not the life itself. When a plant is buried, the soil is enriched with bacteria not only because a vast number of existing soil bacteria decompose and break down the 'plant corpse,' multiplying tremendously in the process, but also because the soil is enriched with bacteria from higher plants as they break themselves down. Certainly, bacteria present in the soil also find abundant nutrients during composting, which allows them to multiply. But, as can be experimentally demonstrated, no bacteria need to enter from the outside whatsoever for decomposition to take place and a breeding ground of bacteria to arise. **Even while alive, higher plants are already enriching the soil with bacteria.**

"It is well known that the root hairs of all higher plants have short lifespans, ranging from a few hours to a few days. New root hairs form and old root hairs die off every day, and the organelles of those that die can revert back to an earlier evolutionary form, namely that of autonomous bacteria. Because of this, every higher plant provides its surroundings with species-specific bacteria during the course of its life. This is also why the rhizospheres around plants contain more bacteria than more distant areas. **This fact has been known for a long time,** but the explanation given by soil bacteriologists is that the rhizosphere contains more bacteria than other soil because the roots' excretions attract them.

"Every higher plant uses this method to populate the soil around it with species-specific, indigenous bacteria. This is why the soil gets richer in bacteria as more plants are growing in it. The issue of 'soil fatigue' among plants is also related to this. There are crops that react negatively to these species-specific, newly-autonomous former organelles, but demonstrate a clear increase in growth rate under crop rotation. **This promises to be a broad, rewarding area of agricultural research.**

"We do indeed kill the organization of the piece of tissue or the seedling with it, but not the life within it itself. As long as their soil continues to receive enough water, dead plants or tissues sooner or later develop into the same bacteria that we can obtain from their seeds, fruits, or stems via aseptic tissue removal. The same thing happens when farmers plow living plants under or when gardeners compost. The soil is enriched with bacteria that originate in the dead plants. The 'death' of the plant gives rise to billions of new lives, not only because the preexisting soil bacteria can use this new nutrient source to multiply, but also because organelles of the 'dead' plant are resuming their lives in the form of bacteria.

"Plant chlorophyll even gives rise to bacteria in animal rumens! Studying the transformation of chloroplasts is so beneficial because the entire process is 'color coded' by nature. The first bacteria from the chloroplasts are initially an unmistakable green color. As they divide and divide, the fat-soluble coloring fades, and after three or four divisions the bacteria are colorless. I performed related aseptic tissue operations in 1933.

"Depending on the type, it took five to ten days for the chloroplasts to begin to transform into motile bacteria in three distinct, but constantly recurring ways. **I was able to record the entire transformation process from intact chloroplasts into the first motile bacteria on photomicrographs.** I published five of the best photomicrographs as part of my article 'Ein Beitrag zur Frage der Herkunft von Weinbakterien' ['A Contribution on the Question of the Origins of Wine Bacteria'] in the magazine *Weinberg und Keller* [*Vineyard and Cellar*] (volume 16, 1969). In the course of this research, it occurred to me to examine what actually happens to chloroplasts from green plants in the stomachs of ruminants. […] I acquired the rumen of a freshly-slaughtered sheep that was filled with fresh green material. To my amazement, the same transformation of chloroplasts into bacteria took place in the sheep rumen, with the same intermediate stages that I was […] consistently able to observe during my experiments with grape chloroplasts. Studying the rumen's contents […] made it clear to me that processes are taking place in the stomachs of ruminants that we had no idea of before. The bacterial flora in the rumen are constantly being replenished by transformed cell organelles that carry on the biochemical activity of the digested plants. There is thus an intimate relationship between cow and plant, a sort of symbiosis of plant and animal. The cows' feces carry a significant portion of the bacteria regenerated from the plant organelles along with it back to the soil. Unlike artificial fertilizers, this sort of fertilizer is full of life and enriches the soil with bacteria, increasing its fertility. **It has been demonstrated time and time again that fertilizing exclusively with chemical, biologicallydead fertilizer salts eventually makes the soil infertile. The soil becomes impoverished if it doesn't contain any living fertilizer in the form of green manure or ruminant feces.** The farmers of the enormous Chinese civilization have been making use of 'living fertilization' for millennia, putting it into practice with the famous Chinese industriousness. I hope that the agricultural 'development aid' we send to developing countries heeds the fact that agricultural problems in the tropics and subtropics cannot be solved by machines and artificial fertilizers alone. Beneficial effects can only be achieved if you think and work biologically above all else, rather than just economically and technologically.

"Modern bacteriology is still too firmly rooted in the monomorphism of the previous century. It still hasn't begun to think evolutionarily. It views bacteria as its own sort of plant, a type that is evolutionarily very old, but had nothing to do with the evolution of the higher plants.

"However, we must simply consider that plant and animals cells, which have been viewed as the smallest building blocks of life up until now, did not simply appear all of a sudden in nature, but followed their own lengthy evolutionary history before nature began to use them as the components of larger life forms." (Author's note: for more on this subject, see France's *Plasmatik* [*Plasmatics*; 1923] and Margulis's *Symbiotic Planet* [1999].)"Over the course of evolutionary history […] primordial cells […] came together into larger cooperative units. The constituent members of these larger cells lost their independence in the union, and were assigned special roles in the new larger cells, eventually becoming functional organs and organelles." (Author's note: see Margulis's "Endosymbiosis" [1999].)"The time will hopefully soon come when these easilyreproducible experiments are incorporated into the curriculum of every practical course on plant physiology. **And the time will soon come that this area of bacteriology will become a fundamental component of the science of cell physiology.** It's true that new discoveries always need time to develop before they are widely accepted. But it seems to me that the amount of time needed in my case shouldn't be necessary anymore in the atomic age."

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