

Sabine Adler

## Stone Turned Into Meat

Sabine Adler talks with biologist Thomas Seppi and artist Thomas Feuerstein about artificial “organs” and PROMETHEUS DELIVERED\*

The screen is bustling with action. Individual liver cells navigate through a nutrient medium and build clusters. Artist Thomas Feuerstein and radiation biologist Thomas Seppi are sitting in front of the monitor, fascinated. “The cells are colonizing a mesh that corresponds to that of the human liver,” comments Thomas Seppi. “Those are polymer fibers that are being populated and then form mesh structures. You can already see their frenetic activity and the first clusters – just like in a functional liver, only in fast motion.” Thomas Seppi and his colleagues from the University of Innsbruck, have developed a live cell imaging tool with which one can observe and film cells under culture conditions for weeks and months. This innovative technology makes it possible to trace the formation of a functional organoid – and thus to watch the growth of an artificial miniature liver in a laboratory.

**Sabine Adler:** *Thomas Seppi, organoids – tiny organs that grow in the lab – are currently one of the most exciting fields of research in biology. A lot of funding is being invested in this area. Even if their use in organ transplantation is still a long way off, they are considered new miracle weapons in the analysis of disease-specific mechanisms and are excellent model systems for tumor and pharmaceutical drug discovery programs. You and Thomas Feuerstein developed an artificial liver structure for a work of art – OKTOPLASMA. This alien-like structure is the outcome of Thomas Feuerstein’s processual Prometheus sculpture. What was special about working with an artist?*

\* Thomas Seppi was born in Bozen, Italy in 1968. He is a human physiologist, an analytical chemist and radiation biologist with microbiological and biochemical background. He works as a postdoctoral research fellow at the Department of Radiotherapy and Radiooncology at the Medical University of Innsbruck, Austria. As well he is doing applied research on projects with nanotechnological topics.

Thomas Feuerstein was born in Innsbruck, Austria in 1968. He lives in Vienna. The artist’s work bridges the interface of applied and theoretical science and his projects combine complex bodies of knowledge from philosophy, art history and literature with biotechnology, economics and politics to create artistic narratives.

**Thomas Seppi:** Thomas Feuerstein came to me with this idea of creating an artificial liver structure that could be exhibited in a museum. The specifications for the size of the liver cell culture alone were very unusual because in the lab we usually work with miniature formats. For me, on the scientific side, collaboration like this is exciting because you go where you would normally never go as a scientist. A monumental living sculpture, this relatively huge cell structure, as seen in Thomas Feuerstein's bioreactor, is anything but frivolous. It was completely unclear whether the whole thing would colonize with cells, whether the hepatocytes would break up at one spot, whether the supply would be sufficient, etc. An organ at this large scale was really a challenge. But I've learned a lot, which indirectly flows back into my research.

*So the sculpture's core is scientific. How does the artistic, the creative process fit in?*

**Thomas Feuerstein:** The structure could have been brought into any shape, taking into account certain parameters such as porosity, size of the capillaries, etc. I chose a hybrid form. In the upper part, OKTOPLASMA is anatomically identical to a human liver – both inside and out. Blood vessels such as veins and arteries follow the anatomical blueprint of a human liver, but it becomes frayed at the bottom and turns into an octopus-like structure by flowing out of eight arms.

*So as a sculptor, you created a biological, an anatomical form?*

**Thomas Feuerstein:** On the one hand, yes. On the other hand, it is also a symbolic form. The octopus stands for the foreign, extraterrestrial like in science fiction. But there is also a direct relation to Greek mythology. The myth of Prometheus tells us overtly that Zeus punishes the Titan and chains him to a rock in the Caucasus for bringing fire, technology and civilization to humans. In truth, Zeus is not at all interested in people or whatever Prometheus is up to. He wants to wrench an old secret out of Prometheus. He wants to know what could threaten his power and rule in Olympus. Zeus is enamored with the sea nymph Thetis, granddaughter of the Titan Tethys, and wants to marry her. Prometheus is aware of the prophecy that the marriage would bring forth a son who would overthrow Zeus. So this undying love would end in death. In the myth, Prometheus is released after divulging the secret and Thetis marries Peleus, a human, and gives birth to Achilles. Before that, however, she transforms herself into a squid in order to escape.

Irrespective of the production of metaphors and allegories, what interests me about art is following real processes and working with matter and scientific methods. Materiality is a special feature of the fine arts. Literature, theater or films are great, but they can only narrate the world using language and images. Fine arts can also make the world of things and processes speak for themselves. This has historically been a shortcoming, but currently makes the fine arts the most relevant art form for me. In PROMETHEUS DELIVERED, different levels – illustrative, linguistic, and molecular – combine to form a narrative knot. There is an incarnation, that is, the material not only proverbially grows, but it literally transforms from the inorganic to the organic.

*Are there other current technologies apart from the specific cell culture you used?*

**Thomas Feuerstein:** The 3D printer plays an important role. With traditional craftsmanship it would not be possible to create such a complex matrix that meets the requirements of an organic sculpture. The necessary porous structure can only be produced by 3D technology. The blood vessels are in the

porous material and there are countless inclusions. These are important to ensure “blood circulation”. Only then can the liver cells settle inside and out.

*Thomas Seppi, working with three-dimensional cell structures in molecular biology is relatively new ...*

**Thomas Seppi:** Flat biology is an important catchword. For a long time it used to be the standard in the active ingredient research of a medication. Simply put, flat biology means that you put a cell culture in a Petri dish and then test different substances. Then comes the stage where you experiment with animals and finally test it on humans. But that was often very unsatisfactory because humans are not two-dimensional – neither in their behavior nor their composition. Every mouse is individual but not every mouse reacts the same way. That’s why we’re to reproduce organoid structures or three-dimensional structures with human cells. These three-dimensional advanced cell culture techniques are a major challenge to science because these structures are not so easy to come by. It has been proven that cells in the third dimension interact with each other in a completely different way, that they react to drugs more similarly than the corresponding cells in the human body.

*There is another interesting scientific phenomenon in PROMETHEUS DELIVERED. The main characters in this mythological-technoid narrative are stone-eating, chemolithoautotrophic bacteria.*

**Thomas Feuerstein:** I was grateful that Thomas Seppi brought them into play. Most of nature is photoautotrophic, that is, it is based on photosynthesis of plants. We are dealing here with organisms that transform something inorganic into something organic. They are stone eaters that engage in chemosynthesis. This is culturally highly charged. The stone is almost the antithesis of the living and the human. When the heart turns to stone, man loses his soul. What’s fascinating is that chemolithoautotrophic bacteria are probably the most extreme thing there is. They live, for example, on black and white smokers in the deep sea, in boiling volcanic springs or kilometers underneath the earth’s crust. In human terms, they are diabolical creatures of the underworld or aliens.

*You’ve been working with Thomas Seppi for 15 years ...*

**Thomas Feuerstein:** Our first joint project was in 2002/2003. It was called “flat::radical individuals – social comrades”. We were breeding cancer cells back then. The cancer cells were allegorical, as well as biological and medicinal, for radical individuals. At that time I saw the body as a composite for society as a closed organism, and this organism is torpedoed by a terrorist act, so to speak, by an individualized immortal cell.

**Thomas Seppi:** The stone-eating microbes are extremophile, able to survive in the most extreme conditions. The archaea and bacteria date back to a time when the earth atmosphere was not enriched with oxygen, but consisted of water vapor, nitrogen and gaseous sulfur and carbon oxides. Many of these archaic organisms have found oxygen to be a cytotoxin and have developed different strategies for releasing oxygen. For the last decades, extremophiles – the chemolithoautotrophs are just one example – have become increasingly important in science because they can take on tasks that other technologies cannot. It began with using those bacteria to leach heavy metals such as uranium out of mines.

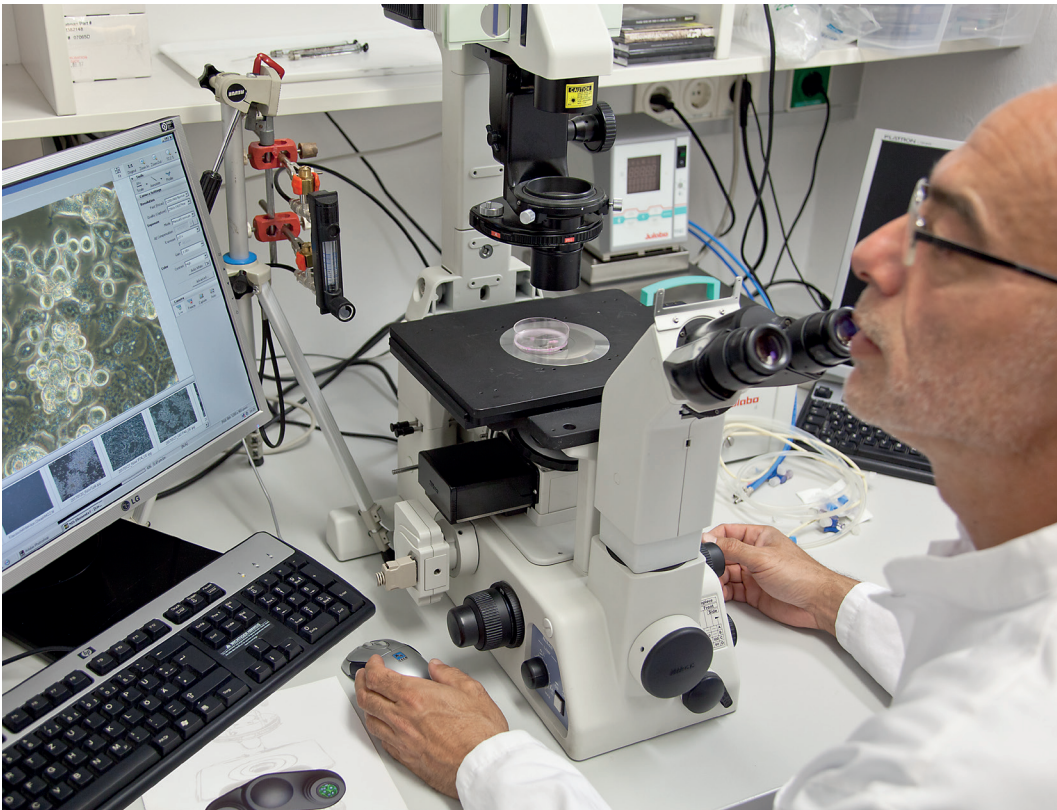
**Thomas Feuerstein:** For me, there are also mythological references here. We talk about age-old evolutionary biological events. In myth, it would be called the Titanic. It is the very, very old, that is, Gaia, the primordial earth, the time before life as we know it today, that arose on the earth's crust. In the myth, the Titans, like Prometheus, had supremacy first. Only then came Zeus, plants, animals, humans and 'zoon politikon'.

**Thomas Seppi:** Calling extremophilic bacteria Titans is quite justified, simply because they have incredible powers and can do incredible things under the most extreme living conditions ... When Thomas Feuerstein approached me with the question whether I could grow liver cells that feed on chemolithoautotrophic bacteria extracts, I was very puzzled at first. That was because it can be done much easier than the roundabout way of stone decomposition ...

**Thomas Feuerstein:** The idea of using stone as the starting point for a process was linked to the myth of Prometheus, of course, but also to my interest in turning dead matter into something alive. Transubstantiation, so to speak, as we know it from changing bread and wine into flesh and blood in the tradition of Catholic liturgy.

*And where did the bacteria come from?*

**Thomas Feuerstein:** From the microbiology department in Innsbruck. Thomas Pümbel, Anna Arthofer and Christian Ebner prepared a biofilm from an Innsbruck sewage system. They knew where to find chemolithoautotrophic bacteria. Because as stone-decomposing bacteria they cause problems in concrete pipes and cause erosion. So we received a very robust bacterial culture that survived the transport from Innsbruck to Berlin and Munich very well. It can even survive up to several months in a dry state.



Thomas Seppi at the Department of Radiotherapy and Radiooncology, Medical University of Innsbruck