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Darina Štyriaková: Today it is popular to say that eco issues are being addressed. But in Slovakia, I don't feel that this is really a priority

People don't normally know that they have to push the competent to invest money in solutions that are accessible.

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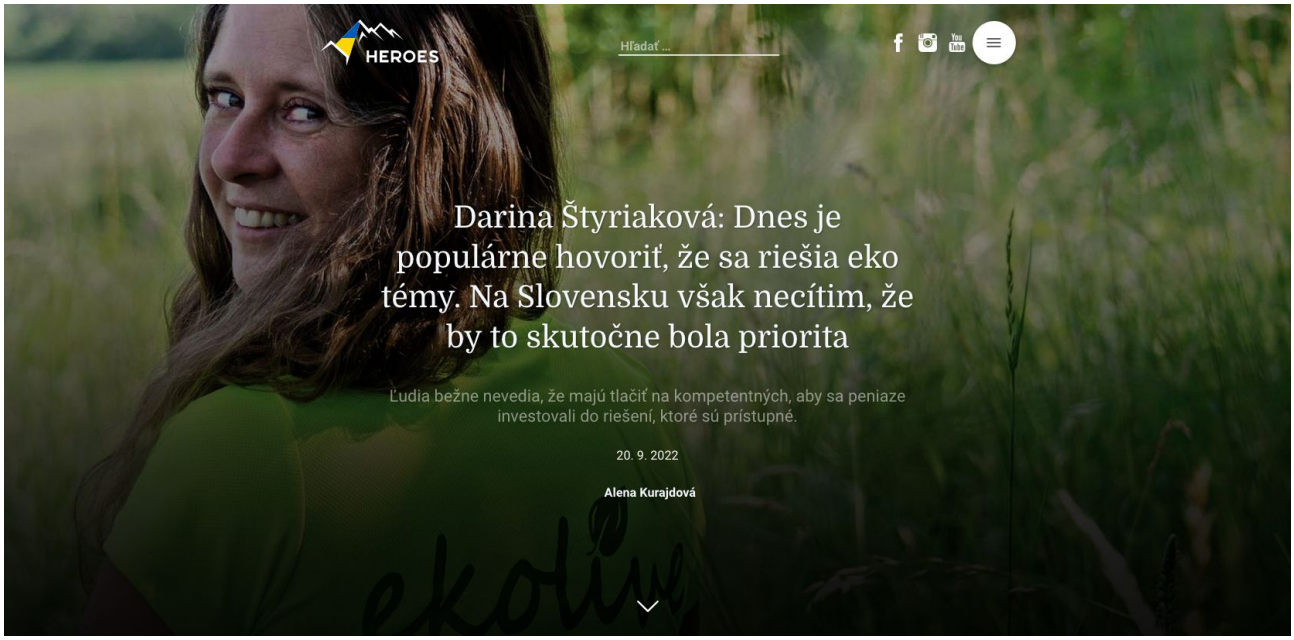

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Darina Štyriaková founded Ekolive three years ago with friends and family. They focus on mineral purification, removal of envirohazards and production of organic biofertilizer using microorganisms.

It has always been a dream of hers to get scientific knowledge out of the lab and into the field, something she is actively working on. Today, Ekolive operates globally, is certified in eco-innovation and one of the top five startups in the world offering bioremediation solutions. Just a few days ago, the company won the WUR award for sustainable innovation in the Netherlands.

We talked about natural soil restoration, the agricultural revolution, the omnipotence of microorganisms, but also how not to give up.

alena: **Your mother brought you to biotechnology and soil. Today you also work together professionally. Do you remember a situation from your childhood that inspired you to decide to follow in your mother's footsteps professionally?**

darina: When I was little, I used to go with her to Dubník to dig opals and I admired what she was doing. I was already doing experiments right in the lab when I was a student. First with sand and then with decontamination of sediments here in Ružín.

The sand was literally being cleaned under my hands. Thanks to my mother, I was able to live that experience for real, not just on paper.

alena: **Imagine you are explaining the technology you have developed to a six-year-old.**

darina: There are a lot of good bacteria in the world that can clean soil and minerals. They do it by their natural activity. Normally this process happens in nature and it is called bioleaching.

You can think of it simplistically as bacteria feeding on pollution to remove it. They can also release the metals that we want to remove from the soil. Alongside this, they produce all sorts of good things that enrich the soil and the plants. We can direct them and make their work more efficient.

alena: **Bioleaching is used around the world, for example, in precious metal mining. How is your technology different from others?**

darina: Yes, it is done with so-called autotrophic bacteria. They break down sulphides, take energy from that and excrete sulphuric acid, which leaches out the metals. That's the use of microorganisms in mineral extraction.

We can do this as well, but we also have our own special way of doing it. We work with the opposite kind of bacteria. They're called heterotrophs, and they get their energy from the decomposition of organics. So they don't decompose sulphides, but they need a carbon compound to live.

This is such as oil, cyanide, phenols and other toxic compounds in the soil, which are food for them. They will use these as their energy source and thus break the organic compounds down to water, to safe end products.

We have developed a way to train and breed them for industrial conditions. Many scientists have started to use such bacteria as well, but they cannot use them effectively outside the sterile environment of the laboratory. We can.

alena: **How did Ekolive come about?**

darina: My mother started bioleaching thirty years ago. She was working in a research team in the field of geology with bacteria. She was fascinated by doing something that they weren't even taught in school. She tried to translate that into practice, but it didn't work at the time.

The reality to this day is that scientific institutions focus on publishing. That's what they are paid to do.

I, like my mother, see the point in practice. I was looking for ways to do it. At the time, in my position, I was awarded a large project for over a million euros to bring this technology into practice. As a first step, I immediately set up a semi-operating plant in Slovenia to clean 300 tonnes of sand where there was demand from industry. Normally, I used to work until the morning. Then it came.

I don't want to go into details, but I simply understood that people have different interests and values incompatible with mine. I accepted that and at the same time decided that I didn't want to do it that way and I wasn't going to do it that way.

alena: **That's probably the point where most people would give up.**

darina: For me, that was the moment when I said I'm going to go it alone. My current co-workers gradually came to my firm. It was difficult for everyone as they left their stable, secure positions. But we all believe in it so much that we said if we can't make it through the institutions we worked for before, we have to make it on our own.

Ekolive has started to run full steam ahead. We were supported by the European Institute of Innovation and Technology and that gave us courage too. We are not a big team. There are seven of us.

alena: **How did you experience entering the business world?**

darina: CI have changed a lot through this whole process. As the company grew, I grew with it. In the beginning, I was an inexperienced little girl. I had to learn how to deal with customers and how to see and understand all the behind-the-scenes moves in the commercial sphere. To watch out for deals and contracts and be really attentive and aware at every step.

It was important for me to learn how to lead a team and be a good manager because people are the foundation. I grew a few hairs grey in the process. In a sense, I've grown up. However, I still retain a little bit of that original free spirit of mine. I climb mountains and sleep in the open.

alena: **What was the turning point for Ekolive?**

darina: First of all, it was our first big project, which started from that semi-operation in Slovenia that I mentioned. A glass company wanted to invest in a commercial operation. It was going to take about 20 000 tonnes of sand cleaned by us per year. We worked like crazy on that and a lot of things got complicated there. The basins were made of clay. That got destroyed. Then we ran out of sugar to feed the bacteria. That got hard and we had to break it up with jackhammers.

I remember one time a contractor brought us late food for the bacteria. They were already in the basin and a terrible storm started. He didn't come until 11 o'clock at night and we were running around in that clay, my shoes were left in the mud, so I was just running around in my socks and sprinkling nutrition on them quickly so they wouldn't die. The transporteur looked at us like we were crazy.

After six months of work that preceded it, 300 tons of sand were ready for the glass industry. Then came corona. They closed the deposit and didn't want to go into a new project. Everything fell through. We had to wait it out.

So we started from scratch. We set up a collaboration in Germany and that immediately brought about a change in our direction. The owner of the deposit for whom we were to clean the sand asked us if we could clean the oil as well. They had catastrophic oil contamination in the soil and this was an even more urgent problem for them.

They had been trying to clean it up for the last twenty years, and it was costing them around 100 000 euros a year. No effect. All of a sudden we were transformed to envirohazards. We were faced with a sore problem that had to be solved, so we went ahead and pumped bacteria underground. In four weeks, the groundwater was 100 percent cleaned and the sand was 96 percent cleaned.

The third turning point is our biofertilizer. That was a surprise.

alena: **How did you come to biofertiliser?**

darina: In Slovenia, they could do various mineral processing under the mining licence. However, our technology is innovative and it was not clear whether this was covered by the mining licence. The locals were concerned and, based on past practices, were also quite sceptical. One lady used to go hide behind a tree and take pictures of us. We were even in the local newspaper. The headline was to the effect that we were aliens from Slovakia and we were doing strange experiments there.

They called the ministry, the mobile lab, the police and the fire department on us. They all looked in amazement at our bubbling pools. Because when bacteria eat, bubbles form on the surface. It looks a bit like science fiction.

They warned us that we must have paper for innovative technology. So we thought about how to treat it legally, and the right way seemed to be through agriculture, because everywhere we poured what the bacteria produced, everything grew great. In the end, our product is tested, certified and sold as a biofertiliser.

I had no idea about farming before. We were focusing on mining, so my colleagues were hesitant. From a business point of view, it seemed better for them to concentrate on just one line of business. But I knew this was incredibly valuable. We completely turned our business model around and land restoration became our priority. With our technology, we could contribute to a real agricultural revolution in a world that definitely needs it.

alena: **What does everything have to do with the condition of the soil? In what all aspects does it affect human life?**

darina: The waste produced by households is only a small percentage of the total pollution. Mineral extraction is a serious problem, as 80 percent is waste from the manufacturing and mining industries. It is often toxic and goes to landfills. The waste is sometimes sealed with foil, but who can say how long the foil will last? All it takes is a small hole and it starts leaking underground. Subsequently, the soil becomes contaminated and this affects the entire food chain.

Plants can adapt. Strawberries, for example, love arsenic, humans do not. However, it enters the human body in small doses through food. It is never flushed out of the body and is the cause of cancer or Alzheimer's. Often a person does not even know what his soil contains. He imagines that he is growing organic unsprayed vegetables in his garden, and in reality he is gradually poisoning himself.

What people are unable to see with their own eyes, they find difficult to put in context.

alena: **How is soil purification done in the world?**

darina: The fact is that Slovakia is an industrial country, and as a result there has been considerable contamination of the environment with PCBs, for example. What is the real state of our country in terms of ecology?

alena: **The fact is that Slovakia is an industrial country, and as a result there has been considerable contamination of the environment with PCBs, for example. What is the real state of our country in terms of ecology?**

darina: We have at least a hundred environmental hazards. PCBs are the Slovak top priority. Here in the east there is the so-called Triangle of Death. People here have the most PCB substances in their blood of any place in the world.

The rate at which envirohazards are being created is much faster in proportion to the tiny percentage of cases solved. A lot of times it's solved by just closing it down. It is stripped or a cover-up is done. But that's only temporary. It is only a matter of time before the insulation becomes non-functional.

alena: **Theoretical question. 100 cities in Slovakia. Would you be able to clean them for the long term?**

darina: It's realistic. But someone has to finance it. Bacteria need to eat.

alena: **What all can be treated with this?**

darina: There is a lot that bacteria can handle. I still find myself pleasantly surprised at what all our technology makes possible.

We base it on the customer's needs. It often happens that someone comes to us and asks us if we could by any chance solve something other than what they originally came in for. We are looking for a solution and this broadens our scope.

alena: **How long does it take and how much does it cost?**

darina: It always depends on the specific environment, but we are talking about weeks. The only cost is food for the bacteria and manpower.

As far as metal pollution is concerned, there we have to supply the organics, the food for the microorganisms, and that increases the cost. With organic pollution, however, it is only a few euros per tonne. They already have plenty of nutrition in the pollution itself and we need to supply them with very little extra. It is a natural process and it is the most economical.

alena: **I think I would like to use a concrete example.**

darina: The owner of a deposit in Croatia, a great guy, invested too quickly in a sand deposit. His idea was to sell the sand in packages. But it was of such poor quality that they didn't even want it on the highway, and for three years he didn't know what to do with it.

When we figured out that our by-product was biofertilizer, I contacted him right away because I knew he was sitting on tons of unusable sand that he couldn't sell. Low quality sand means a lot of impurities for industry, but a lot of nutrients like iron, manganese, zinc, calcium and magnesium for agriculture. Now we have a joint venture.

If he was supplying sand for glass production, he would get a maximum of €20 per tonne, but now a tonne of his cleaned sand is worth €7000. Plus he still produces 4000 litres of fertiliser from each tonne and a litre is usually sold from around 50 cents per litre depending on the quantity ordered.

alena: **In principle it sounds very simple. How is it that putting it into practice is proving difficult?**

darina: Everybody who knows our technology says that everybody has to jump on it right away. But bureaucratic processes slow down the application in practice.

The biggest companies are interested and we are working with them. We test their materials on a small scale, but it takes a long time for them to get to the decision within their processes to allow us to do it on a large scale. It's about logistics in a particular company, in a particular ministry.

I see the way more through smaller companies or farmers. In Slovakia, Patrik Magdoško, who grows melons and strawberries, is testing our biofertiliser. He is a man who is interested in action. He has tried our biofertiliser on his crops, is satisfied with the results and would like to become one of our distributors.

alena: **That brings me seamlessly to the question about the EU passing the Land Act. As part of the EU, we have committed ourselves to certain conditions in this area. Has anyone competent come to you to distribute the money? I mean the state representatives.**

darina: EU money for remediation of envirohazards is earmarked, but it is not usually used very effectively. And when they are not spent, they are used somewhere else. The money and the European projects are up to the public institutions. These are mainly focused on monitoring, research in the laboratory or publishing. However, this does not provide a real solution outwards. Publication or monitoring will not solve the real envirohazard, an active solution on the ground is needed.

There is a lot that needs to be addressed, but the money usually does not get to the people who can actually use it for applicable solutions.

We have already contacted our ministry, but there has been no response. Little is yet known about innovative practices, and perhaps this fact also makes it difficult to put them into practice. That is why we are telling everyone about it. Normally, people have no idea about our economic and ecological technology and therefore do not even know that they have to push the competent to have the envirohazards removed and the money invested in real solutions that exist and are accessible.

alena: **Who can become your customer? If I were a small farmer, for example?**

darina: Our customer can be the smallest gardener, big companies or even the state. We can come on site and take pollution measurements or the customer can take a sample and mail it to us and we will do the analysis.

We have environmental monitoring equipment and also innovative technology, so why not help ordinary people straight away?

Depending on the problem the customer wants to solve, we usually set up the whole procedure on a small sample of soil or other mineral or waste. So what bacteria to use, how long it will take and how much it will cost. Either we sprinkle the soil with bacteria on site, or we make boreholes and drop the bacteria deep underground with their nutrients so that they are active and multiply. When we stop feeding them and they eat all the contamination as well, they will naturally die off.

alena: **What were your first feelings and impressions when you physically found yourself on the banks of the Slaná river?**

darina: Personally, I was very touched because I love our nature and this is really a huge disaster. We have been helping with our bacteria in envirohazards almost all over Europe and when I saw that a new envirohazard was forming right before my eyes here at home, I felt that we had to try to stop this disaster as soon as possible.

alena: **The river has been polluted since February this year. What is the current situation?**

darina: There are bacteria in the mine in Nižná Slana that decompose sulphides, they produce sulphuric acid and thus the process of classical bioleaching, which is how gold or copper is mined in the world, has taken place right in the mine. In this case, arsenic, nickel, iron and manganese are leached into the water that flows out of the mine. That's why the whole river was red, because it's back-oxidizing there.

The river is already, unfortunately, full of metals and toxic elements that are being added there every day. But this is just one of the first manifestations of the source of the problem, which is deep underground. If the envirohazard is really to be solved, the source of the pollution needs to be removed. Attempts to clean up the river or the run-off water will not solve the cause of the problem, only its effect. Groundwater flow will continue to produce huge quantities of water with dissolved metals and toxic elements until the reaction underground is stopped.

At first, the state claimed that the situation was normal. We took matters into our own hands and were supported by the Košice Self-Governing Region. We went out to monitor the river bed, the metal content in the sediments and the mine run-off water with our own field XRF spectrometer, which measures the elements in laboratory quality and, most importantly, provides data from fresh samples.

We found that the problem of metals in mine run-off water was not solved even by diverting surface water. We also met with local activists. I admire their determination to fight for our environment. This, too, has reassured us that the interest is there and it is worth trying to propose solutions and take further steps to make the solution economic.

The President declared a state of emergency after visiting the site. The crisis staff met and we did not have access. The information was often chaotic. There were many reports in the media about clean water leaking out, although the reality was different.

So we took the next step. As part of our collaboration with colleagues from the University of Miskolc, we arranged an attempt to survey the mine with an underwater drone, with the additional possibility of monitoring the mineralogy, identifying the resource and creating a 3D map of the mine.

They came at their own expense with no fee. They are also concerned about how this will affect the environment in Hungary. At the same time, we tried various treatments to the mine water that was flowing out and took the precipitated metals to US Steel to verify their industrial use.

They came at their own expense with no fee. They are also concerned about how it will affect the environment in Hungary. At the same time, we have tried various treatments for the mine water that is leaking out and have taken the precipitated metals to US Steel to verify their industrial use.

alena: **Articles are starting to appear everywhere with headlines about how the situation has been resolved. Pumps are pumping the uncontaminated water out to reduce the pressure and discharge of contaminated water.**

darina: Yes, but that may not be a permanent solution. There are an estimated nine million cubic meters of groundwater underground in the mine, and most of it is heavily contaminated. All it takes is for the groundwater level to rise and the situation could get worse again.

My understanding is that they have made a very good move and are currently managing to keep the contaminated water underground, which is great. However, the solution to the cause that would remove the contamination completely has not happened yet.

alena: **What would you suggest as a long-term solution to the situation?**

darina: Stabilize the weathering of sulphides with liquid soil, where we add bacteria that precipitate metals instead of leaching.

Simply put, they reverse the process. That is, the minerals will not decompose as they do now, but new ones will be formed in solid state from the dissolved ones with the help of the bacteria. We can use all the contaminated river sediments and mining waste from around the affected area to make liquid soil.

alena: **The bioleaching system you have developed is of interest abroad and is already being used in Germany, Spain, France and Croatia, even in Dubai. I would have expected the Slovaks to be the first to jump on the technology developed in Slovakia, which is both time- and cost-effective. How do you explain that this is not the case?**

darina: We approached Slovakia, but there was no response. Only in the Košice Self-Governing Region did they show us support. But I am not so disappointed. I accept it and I help wherever there is interest. Of course, I would like there to be interest at home as well.

It is certainly popular nowadays to say that eco issues are being addressed. However, at the moment I don't feel that this is really a priority.

alena: **I would like to come back to the agricultural revolution you mentioned earlier and your biofertiliser.**

darina: I would never have thought that the treatment of mineral raw materials would lead to biofertiliser.

In Germany, too, we treat mining waste in this way, which should go to landfill, even though in this case it contains nothing toxic, only good things, and the people concerned have to pay for it. In this way, it can be transformed into a valuable raw material. A tonne of waste or low-value mineral can be used to produce 4 000 litres of biofertiliser containing nutrients for plants.

The waste is purified by our technology. They make money out of it and farmers can afford to buy it. They are able to replace a significant amount of chemicals in agriculture and at the same time the soil is restored.

alena: **Describe your biofertilizer.**

darina: It's a nutritious smoothie for the soil and plants that typically contains up to 17 important nutrients from dissolved natural minerals. Also, naturally produced effective organic acids and probiotic bacteria support plant growth and immunity. They displace pathogens. Roots are stronger and plants are larger, producing more fruit.

Another added value is that the bacteria modify the soil structure. This means that the soil retains more water and up to 25 percent less has to be used for irrigation. They also fix CO_2 from the air and convert it into organic compounds.

Europe's green deal may lead to crop losses for farmers as the EU wants to limit the use of agrochemicals. The EU is pushing farmers to go down this route, but they have little return if they switch to organic farming. Our technology could solve that. They would be organic and at the same time have higher yields.

Our intention is to gradually distribute our biofertiliser to countries around the world. We want to start it first in Europe and then expand to Africa and other countries like Sri Lanka and the Arabian Peninsula. We already have local contacts there. In Kenya, for example, they live mainly on potatoes and we can double their production. Imagine the impact that could have in a country that is struggling with food shortages.

alena: **You've been operating for exactly three years. What do you imagine the next three will be like?**

darina: I think we'll be much further along. In these three years we have managed to make contacts and have been noticed globally. We have already been rated as one of the top five bioremediation startups in the world. We have projects with the biggest mining companies. Two big desert sand projects for the princes of Qatar and Dubai. We also work with research institutions, so when something is happening, we immediately hear from universities around the world.

We have built up very good relationships and exposure abroad. Hopefully in the next three years it will be similar at home.